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Sugaya et al.

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(45) **Date of Patent: Feb. 9, 2016**

(54) **ARM FOR CONSTRUCTION MACHINE**

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(73) Assignee: **HITACHI CONSTRUCTION MACHINERY CO., LTD.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 137 days.

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E02F 3/38 (2006.01)

(52) **U.S. Cl.**
CPC ***E02F 3/38*** (2013.01)

(58) **Field of Classification Search**
CPC G01N 2291/267; G01N 2291/2675; E02F 3/38
See application file for complete search history.

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(57) **ABSTRACT**

An arm of a hydraulic excavator is formed as a box-shaped structural body surrounded by left and right side plates, an upper plate joined to each of the upper end sides of each side plate, a lower plate joined to each of the lower end sides of each side plate, and a thick rear plate joined to each of the rear end sides of each side plate and the upper plate. The side plates are formed by joining a rear thick side plate and a front thin side plate. The upper plate is formed by joining two members, that is, a rear thick upper plate and a front thin upper plate, and the lower plate is formed by joining two members, that is, a rear thick lower plate and a front thin lower plate.

11 Claims, 16 Drawing Sheets

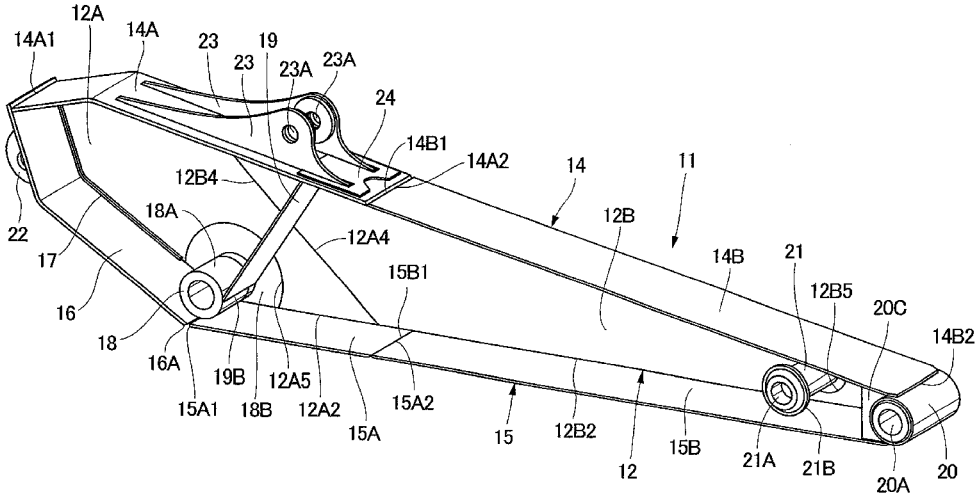

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Fig. 1

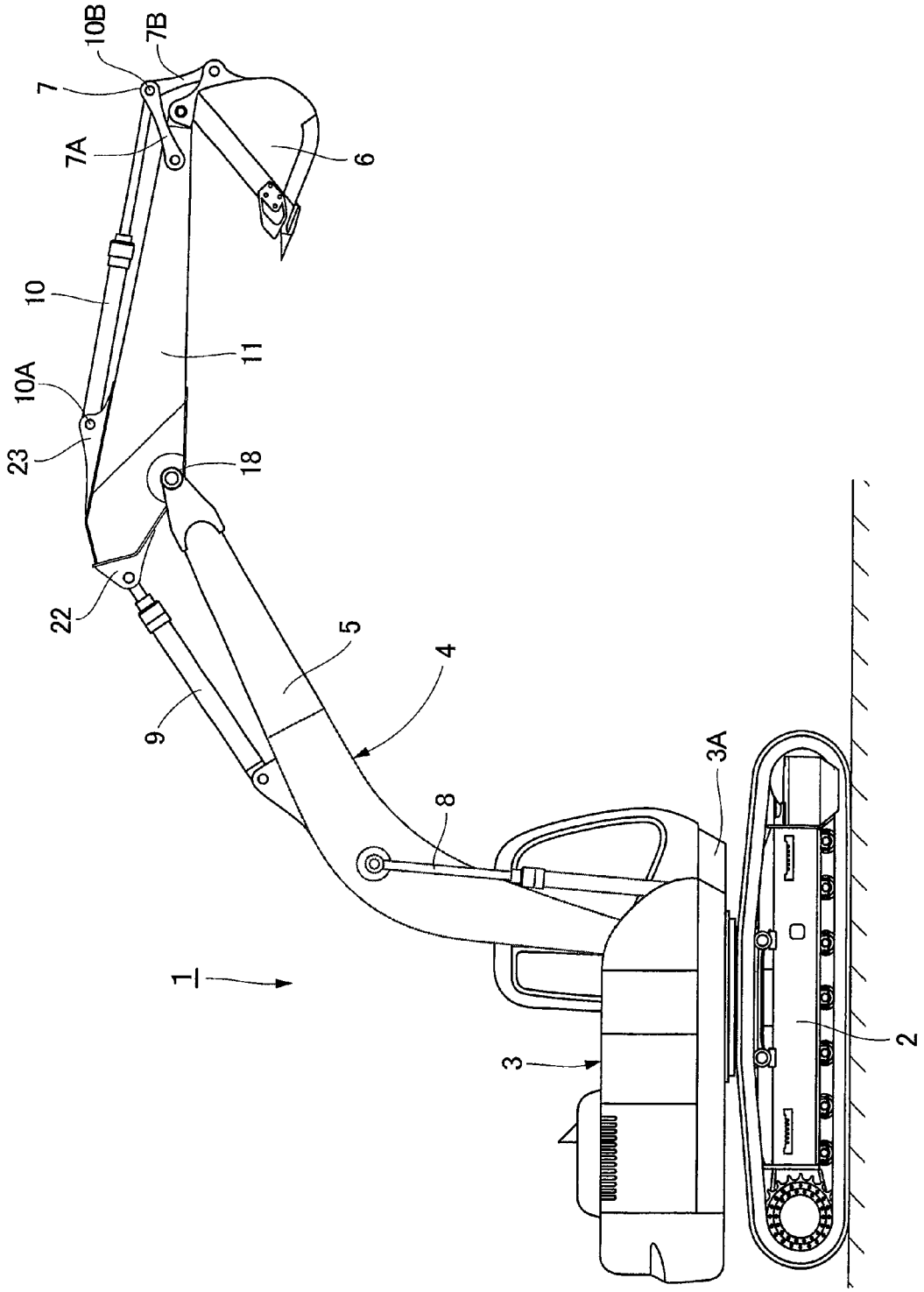
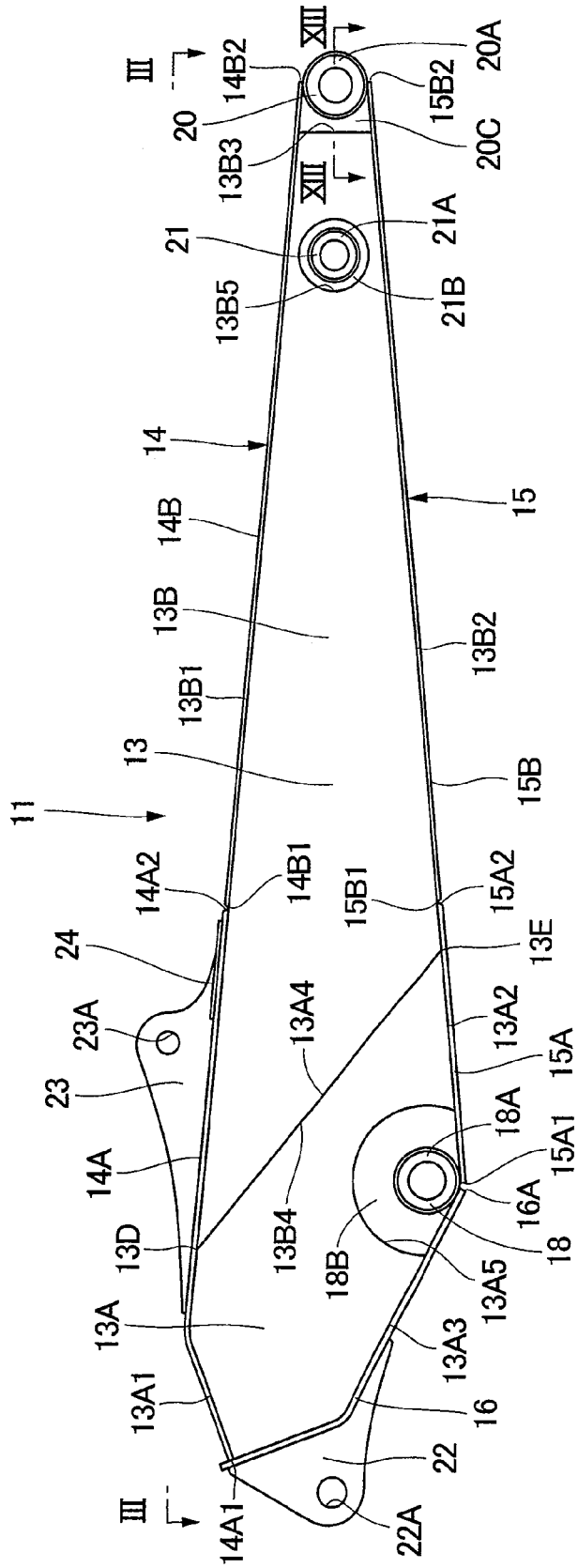


Fig.2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20C
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13B5
21B
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13B
13B2
13B1
13
15B
11
14A2
14B1
15B1
15A2
24
13E
23A
13A4
13A2
15A
23
18A
14A
15A1
16A
13D
13B4
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18B
13A5
13A
13A3
13A1
16
22
III
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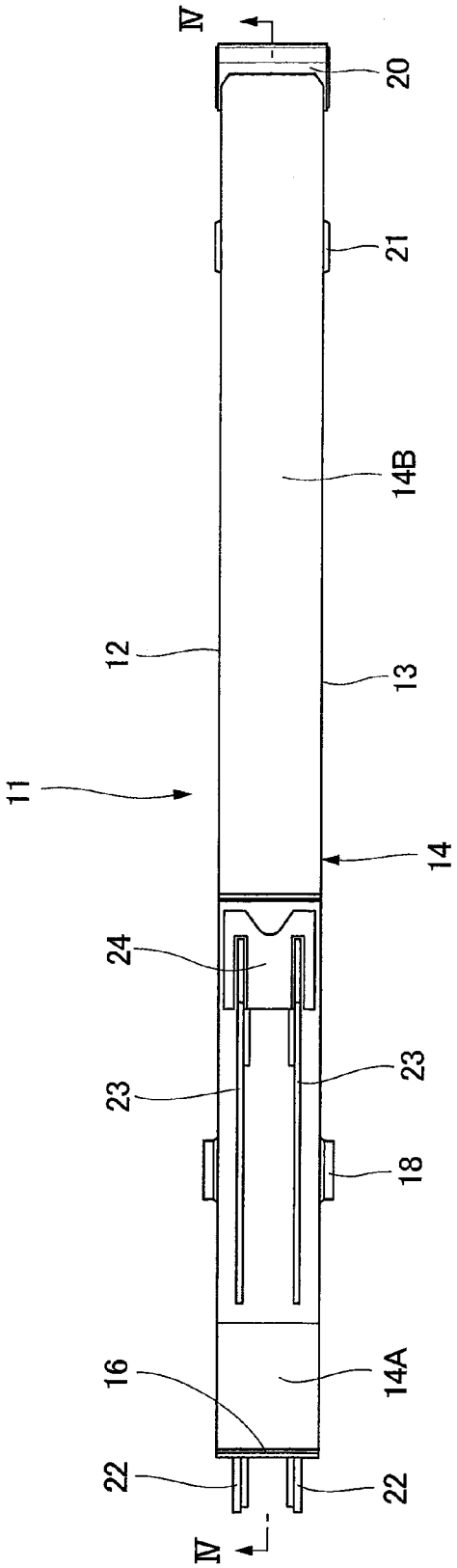
22A

Fig. 3



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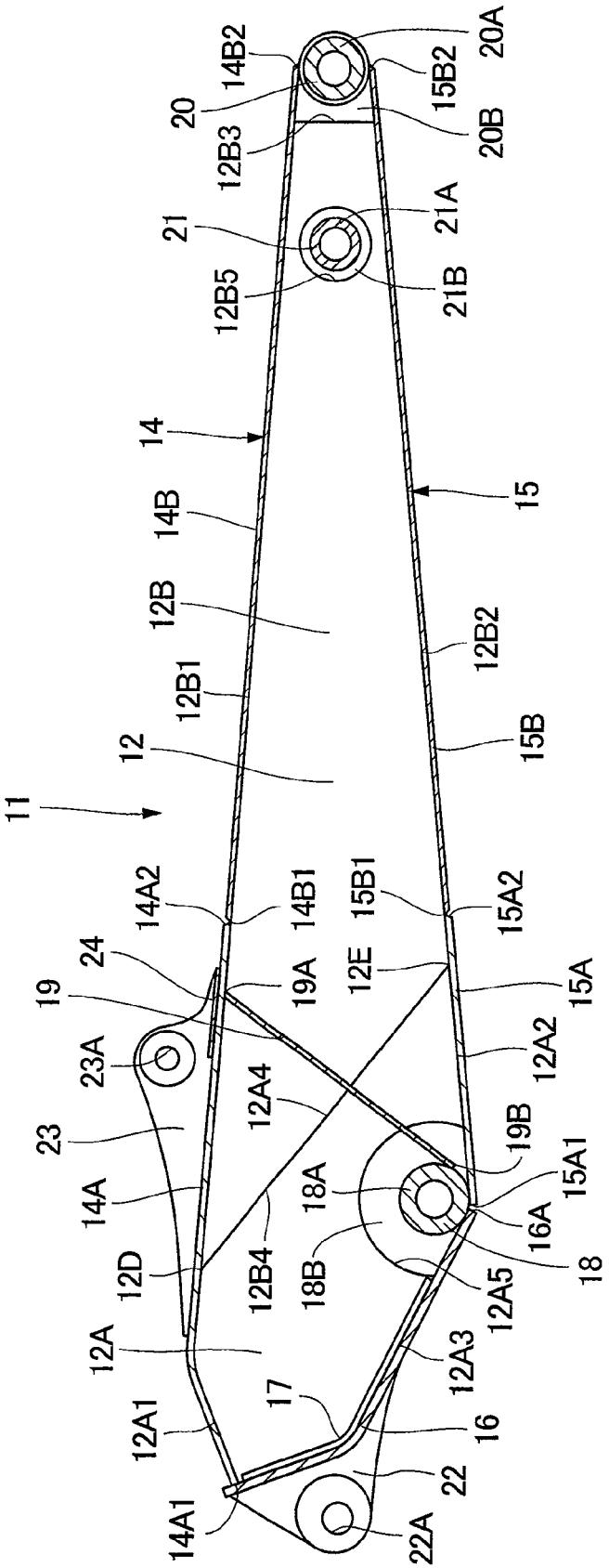
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12A5
12B
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12B2
12B3
12B4
12B5
12D
12E
14
14A
14A1
14A2
14B
14B1
14B2
15
15A
15A1
15A2
15B
15B1
15B2
16
16A
17
18
18A
18B
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19A
19B
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20A
20B
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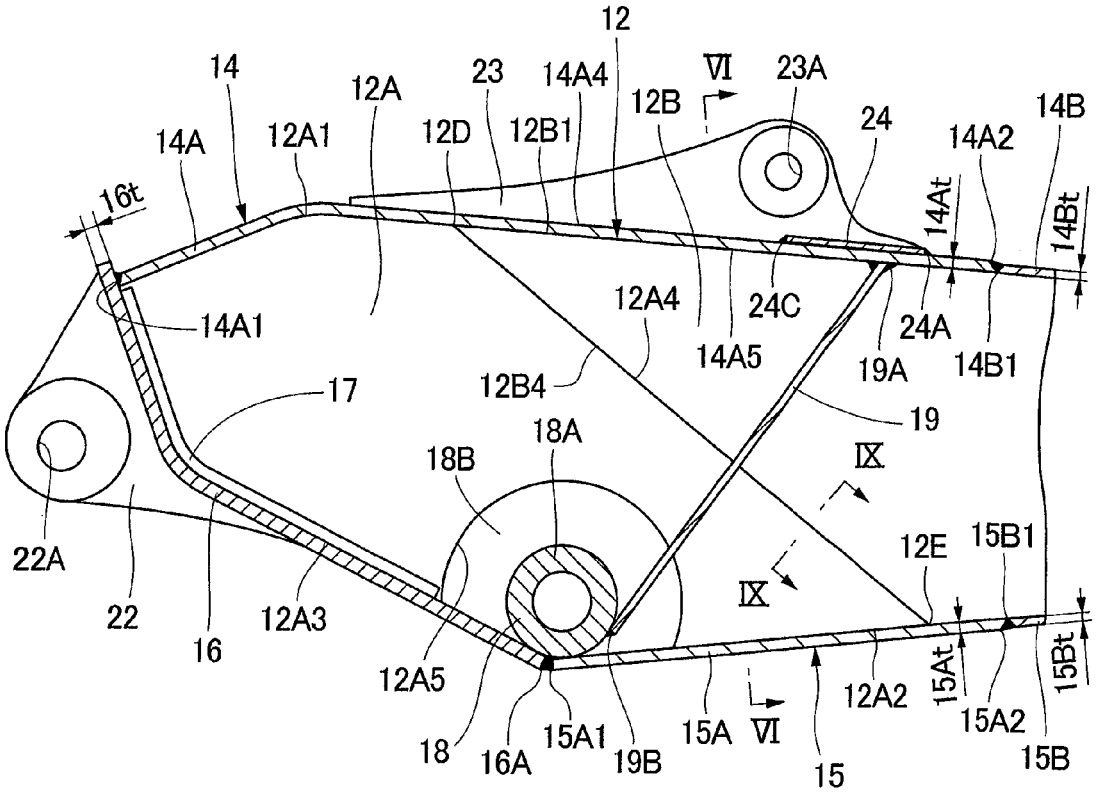
21A
21B
22
22A
23
23A
24

Fig.5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14A
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12D
12B1
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14At
14Bt
14A1
12A4
24C
24A
14A5
19A
14B1
12B4
17
19
18A
18B
IX
22A
12E
15B1
IX
22
16
12A3
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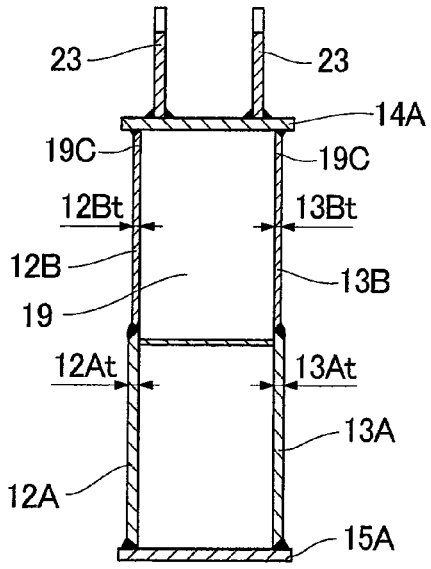
16A
15A1
19B
15A
VI
15
15B

Fig.6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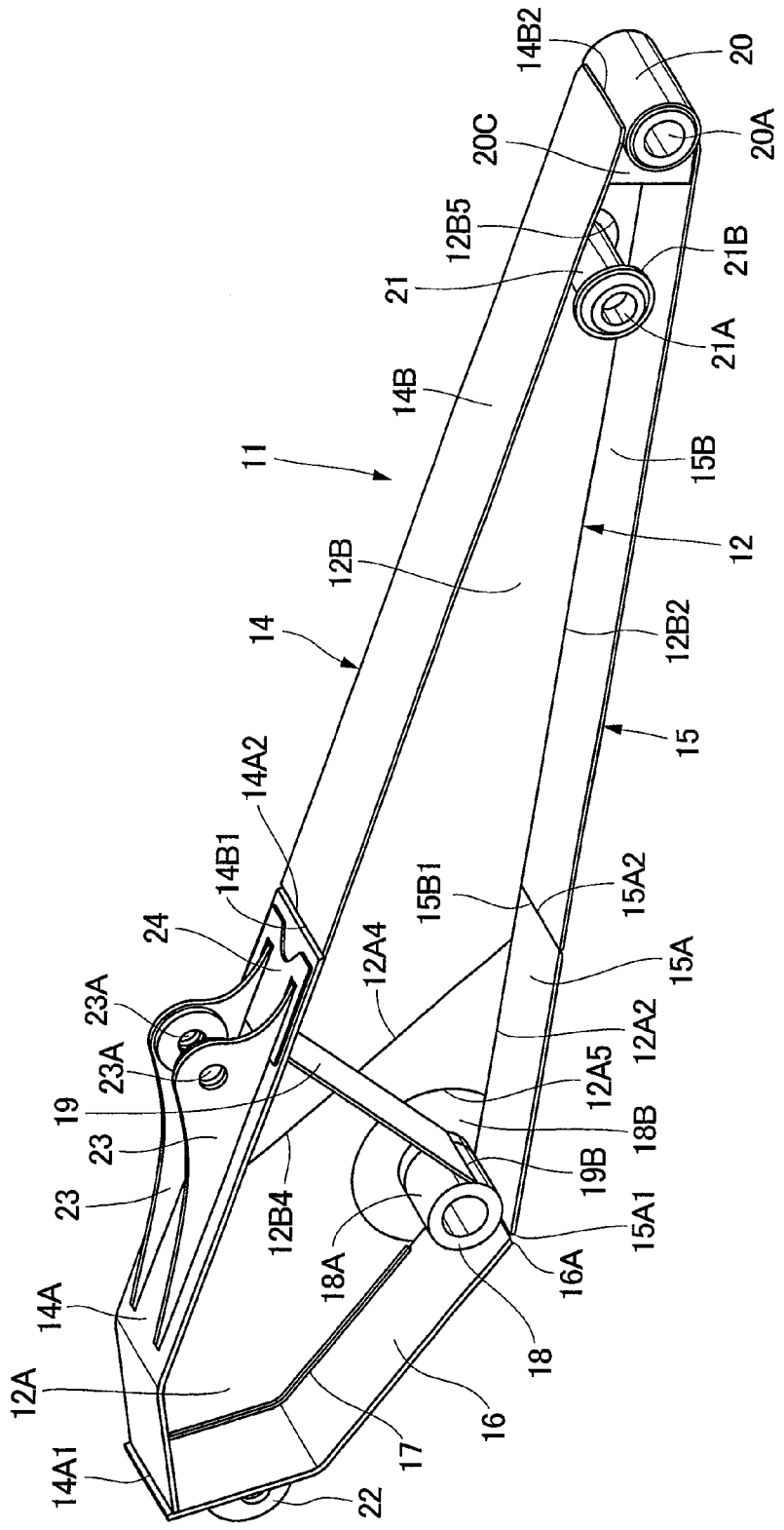
13B
19
12At
13At
13A
12A
15A

Fig. 7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21B
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21A
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12B
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12B2
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14A2
14B1
15B1
15A2
24
12A4
15A
23A
12A2
23A
12A5
19
18B
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14A
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12A
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14A1
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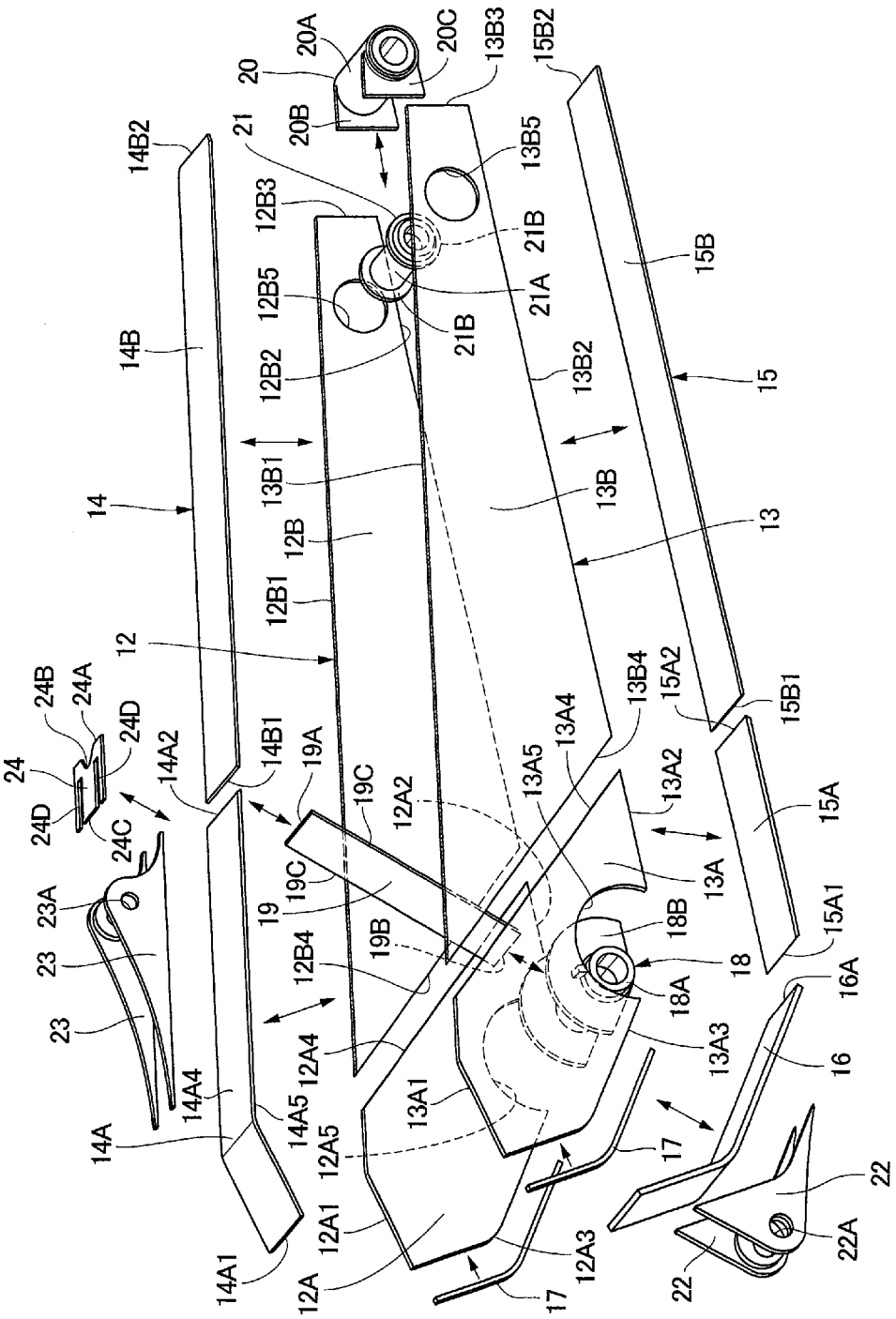
Fig.8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15B
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13B1
13B
14
12B
13
12B1
12
24B
24A
24D
24
24C
14A2
14B1
19A
19C
12A2
13A5
13A4
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15A2
15B1
13A2
15A
24D
23A
19
19C
13A
18B
15A1
23
12B4
19B
18
18A
16A
23
12A4
13A3
16
14A4
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13A1
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14A1
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12A3
17
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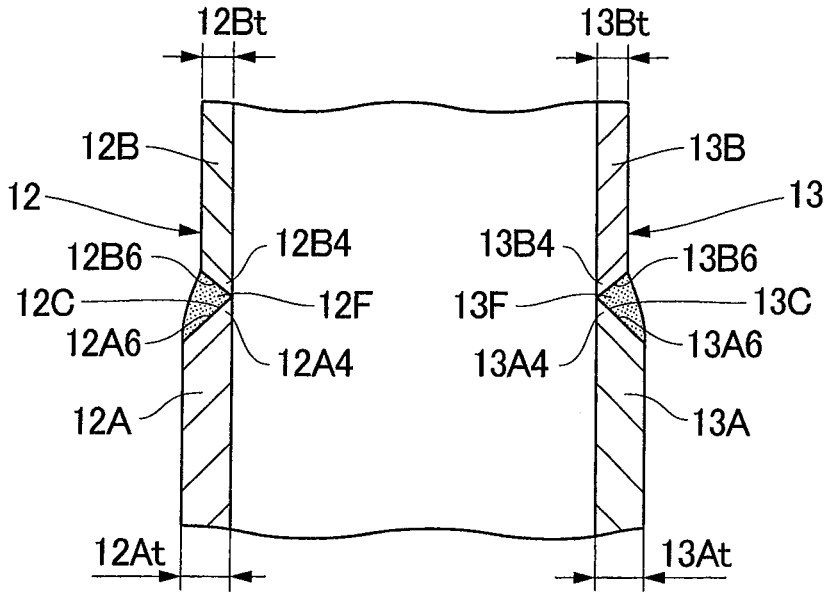
Fig. 9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13B4
13B6
12C
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13F
13C
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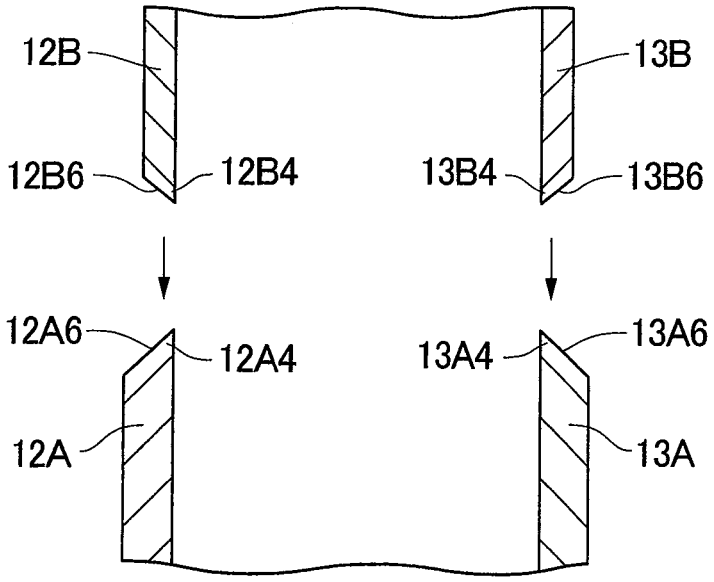
12A4
13A4
13A6
12A
13A
12At
13At

Fig. 10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13A6
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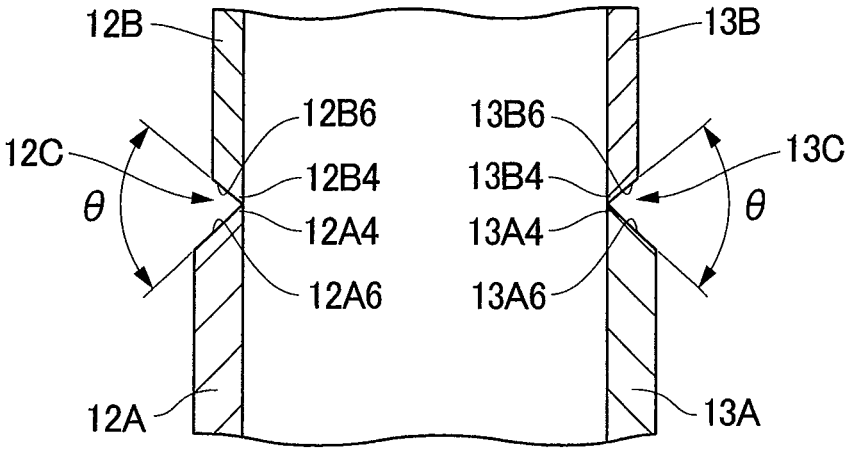
13A

Fig.11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13B4
θ
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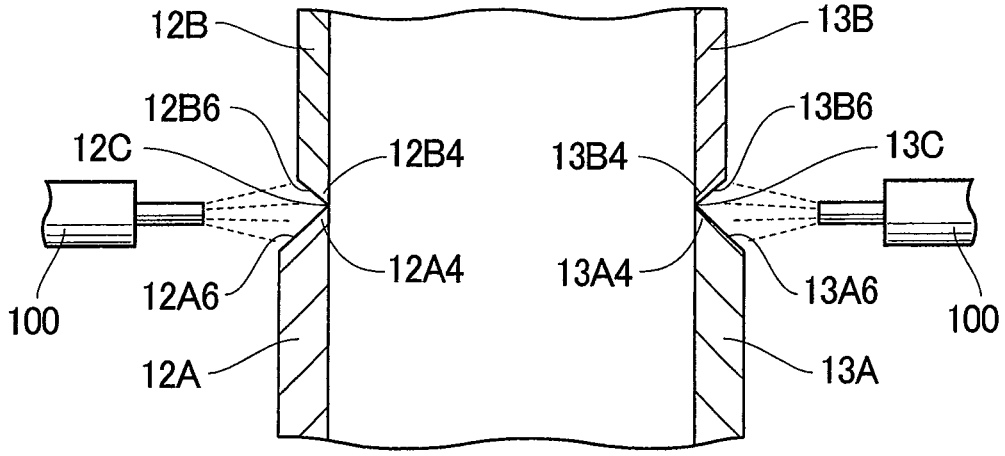
13A4
12A6
13A6
12A
13A

Fig.12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13B4
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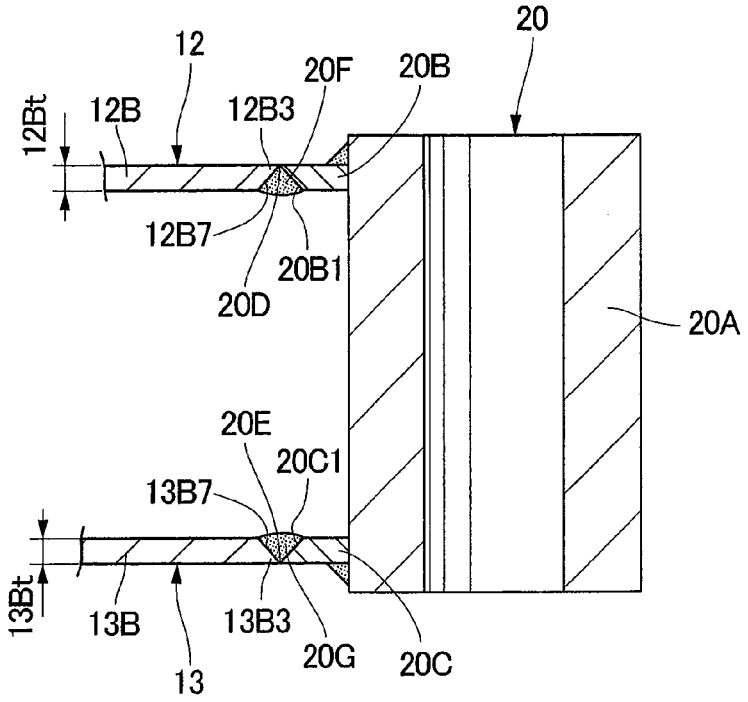
12A6
13A6
100
12A
13A

Fig. 13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13B
13B3
20G
20C
13

Fig. 14

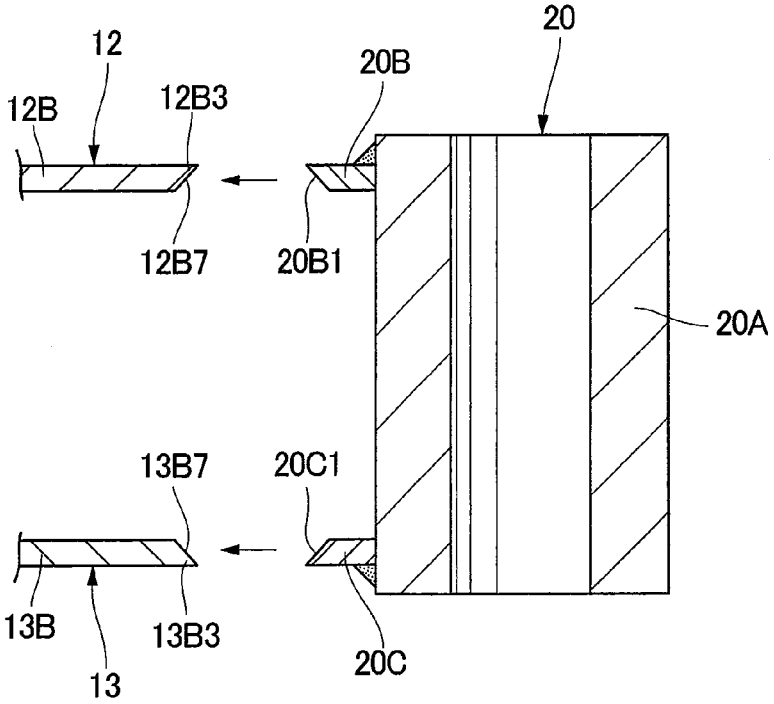
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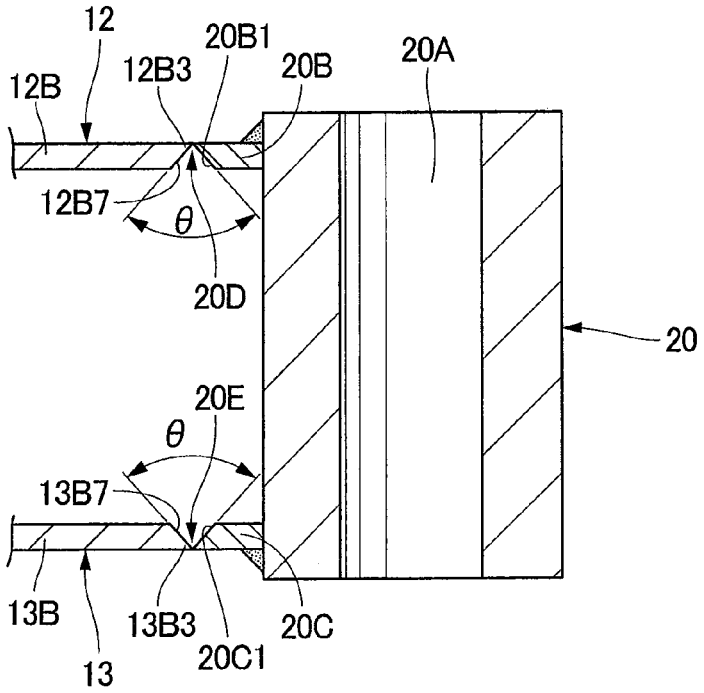
Fig. 15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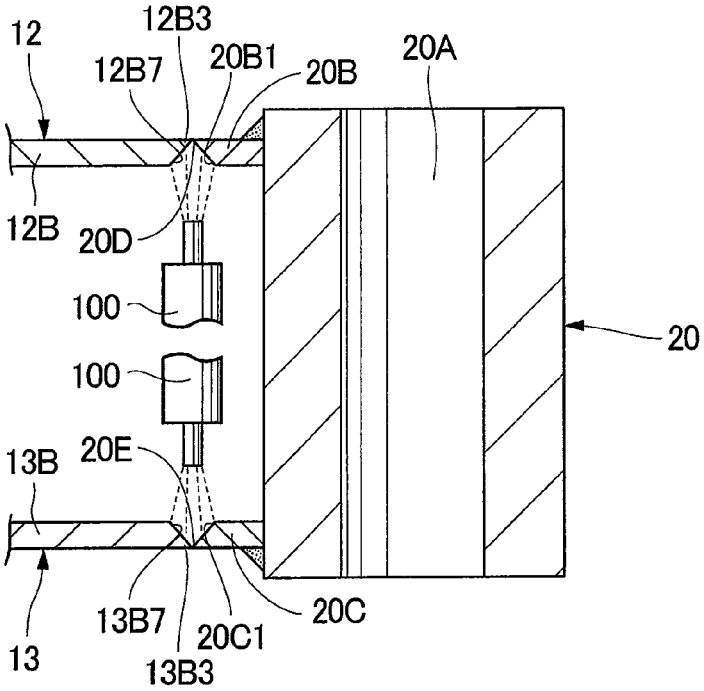
13

Fig. 16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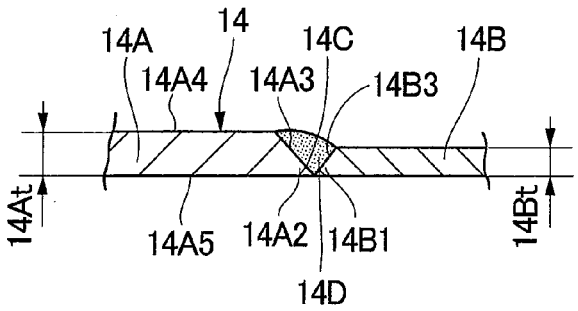
13B3

Fig. 17



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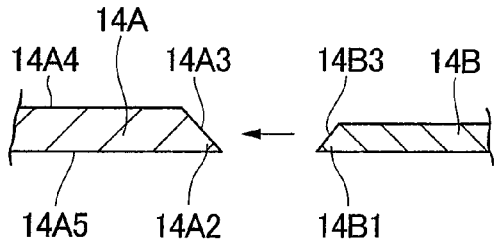

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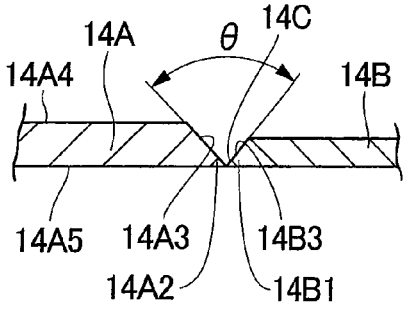

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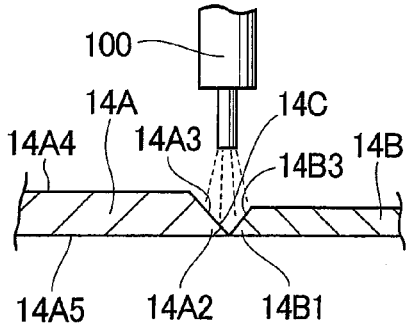

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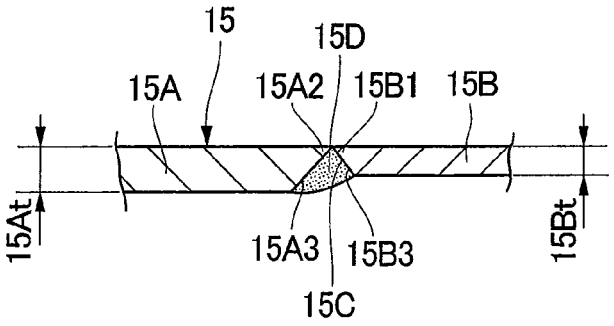

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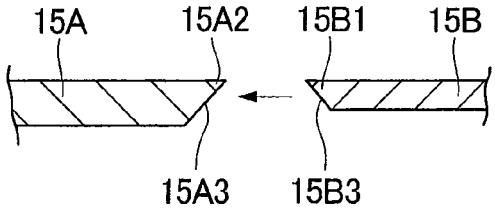

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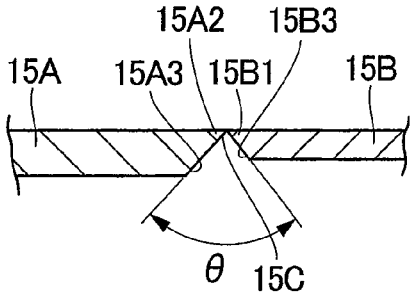

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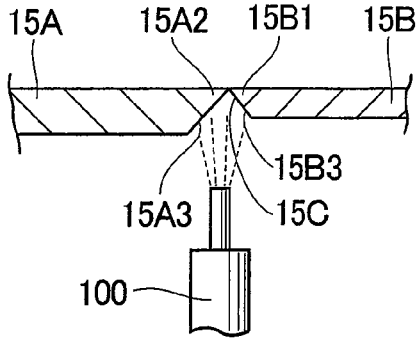

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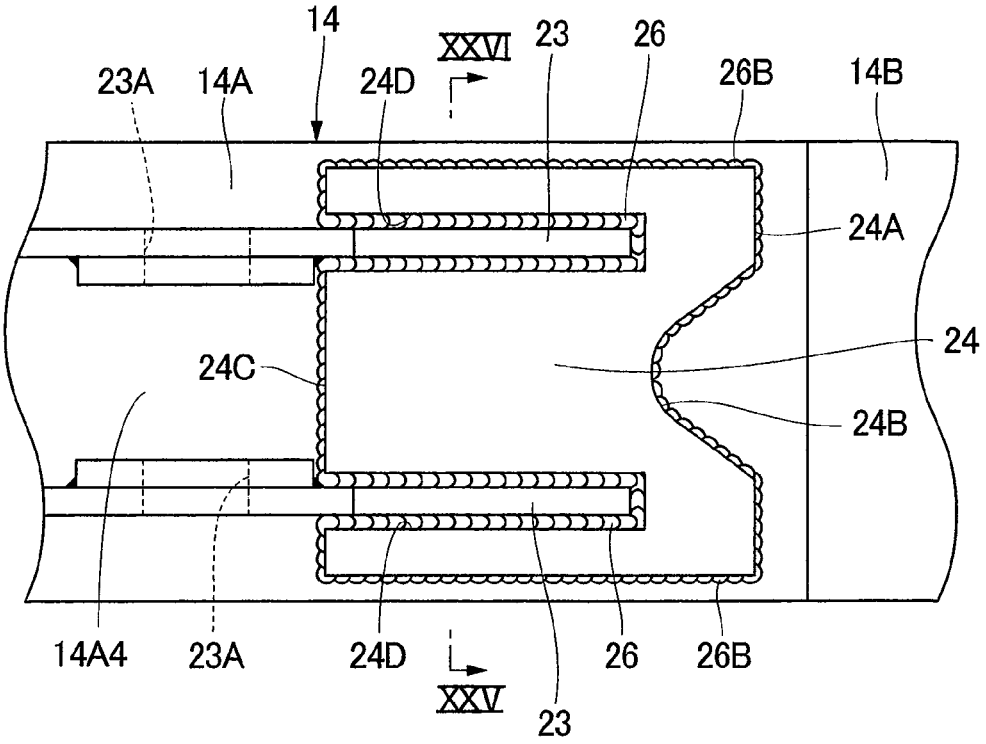
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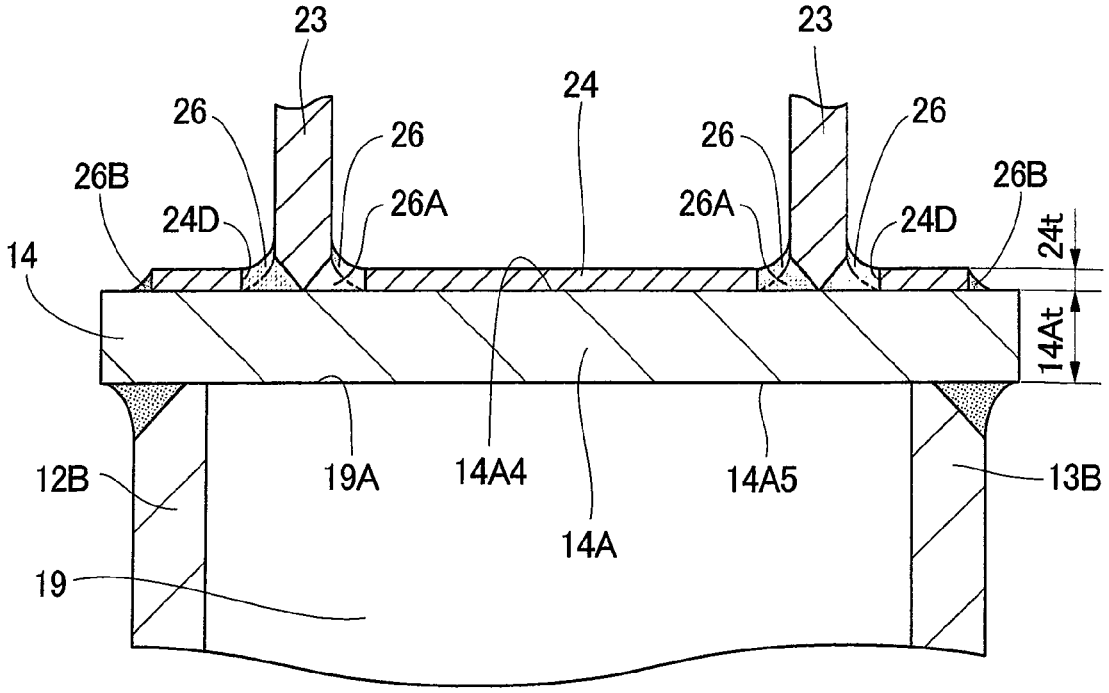
Fig.26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14A
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Fig.27

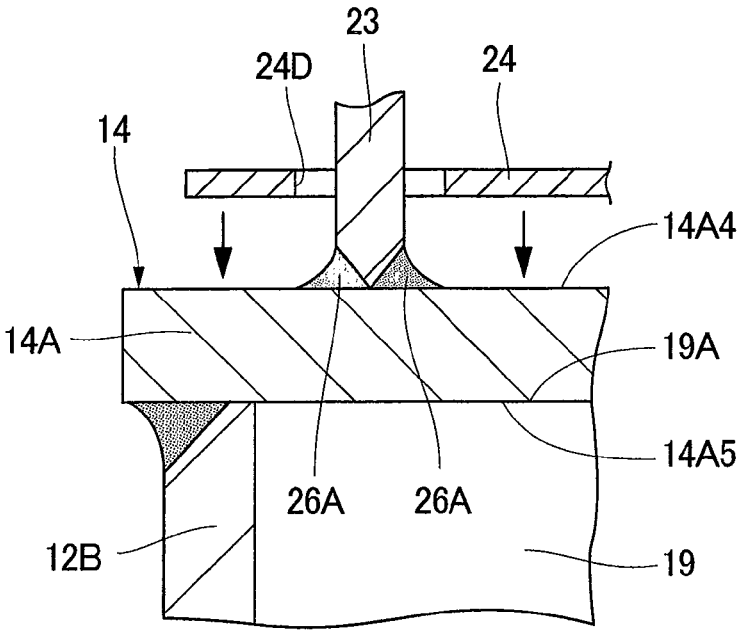
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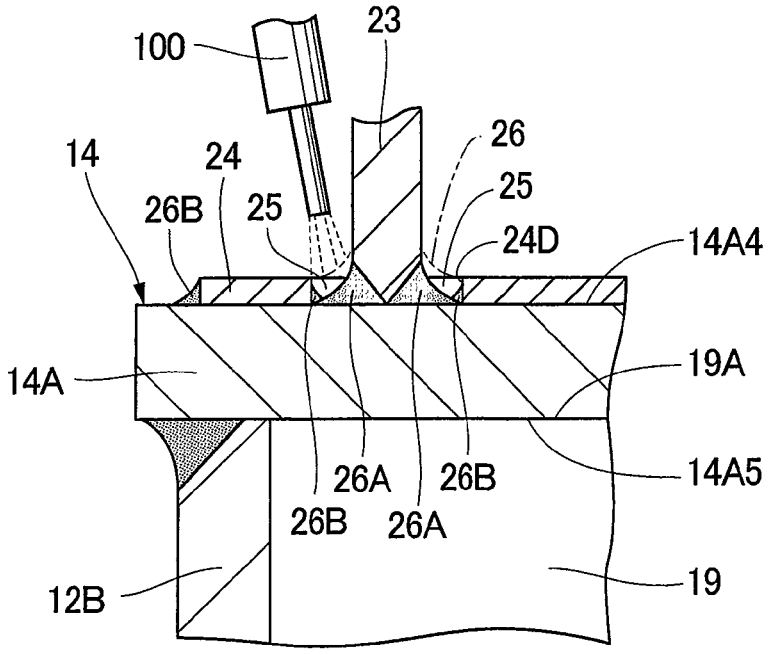
Fig.28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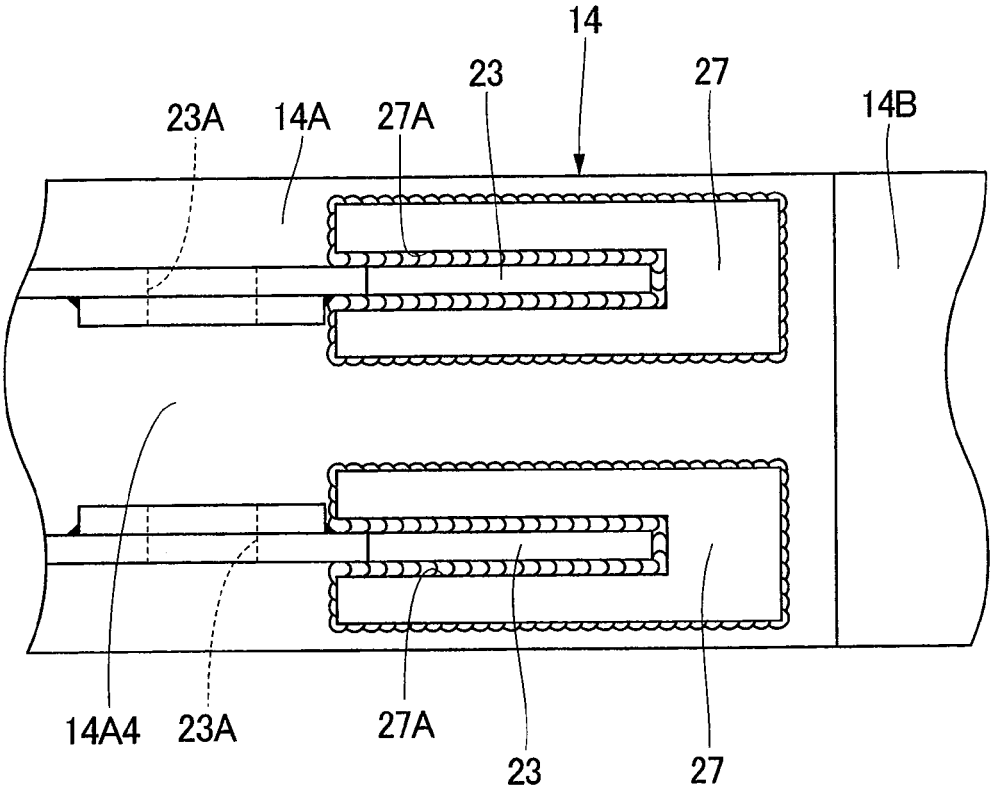
12B
19

Fig.29



ARM FOR CONSTRUCTION MACHINE

TECHNICAL FIELD

The present invention relates to an arm for construction machine suitably used in a working mechanism mounted on a construction machine such as a hydraulic excavator and the like, for example.

BACKGROUND ART

In general, a hydraulic excavator which is a typical example of a construction machine is composed of an automotive lower traveling structure and an upper revolving structure rotatably mounted on the lower traveling structure. On the front side of a revolving frame constituting the upper revolving structure, a working mechanism performing excavating work of earth and sand and the like is provided capable of moving upward/downward.

Here, the working mechanism of a hydraulic excavator is usually largely constituted by a boom having the base end side rotatably mounted on the revolving frame, an arm rotatably mounted on the distal end side of the boom, a working tool such as a bucket or the like rotatably mounted on the distal end side of the arm, and a boom cylinder, an arm cylinder, and a bucket cylinder driving the boom, the arm, and the bucket, respectively.

The arm constituting such working mechanism is usually formed as a lengthy welded structural body whose entire length is as long as several meters. That is, the arm is formed of left and right side plates, an upper plate joined to the upper end sides of these left and right side plates by welding, a lower plate joined to the lower end side of the left and right side plates by welding, and a rear plate joined to the rear end sides of the left and right side plates and the upper plate by welding. As a result, the arm is formed as a box-shaped structural body having a cross sectional surface of a square closed sectional structure.

On a rear part on the lower side of the arm, a boom connecting boss to be connected to the distal end side of the boom by using a connecting pin is provided, and on the rear end side of the arm, an arm cylinder bracket to which the arm cylinder is connected by using a connecting pin is provided. On the other hand, on the rear part on the upper side of the arm, a bucket cylinder bracket to which the bucket cylinder is connected by using a connecting pin is provided. Moreover, on the front end of the arm, a bucket connecting boss to which the bucket is connected by using a connecting pin is provided (Patent Document 1).

PRIOR ART DOCUMENT

Patent Document

Patent Document 1: Japanese Patent Laid-Open No. 2003-261956 A

SUMMARY OF THE INVENTION

Since the boom connecting boss, the arm cylinder bracket, and the bucket cylinder bracket are provided on the rear side of the arm, strength required for the arm is larger on the rear side than on the front side.

On the other hand, the above-described conventional art arm is usually formed of an upper plate and a lower plate by using a single plate material such as a steel plate material having a uniform plate thickness. Thus, on the front side of the arm, the plate thicknesses of the upper plate and the lower plate are tend to be too large for the required strength, and there is a problem that a weight of the entire arm becomes larger than necessary.

In view of the above-discussed problems with the conventional art, it is an object of the present invention to provide an arm for a construction machine which can reduce the weight of the entirety while ensuring required strength.

(1) In order to solve the above-described problem, the present invention is applied to an arm for a construction machine formed as a box-shaped structural body having a square cross sectional surface having left and right side plates, an upper plate joined to the upper end sides of the left and right side plates by welding, a lower plate joined to the lower end sides of the left and right side plates by welding, and a rear plate joined to the rear end sides of the left and right side plates and the rear end side of the upper plate by welding, comprising: a boom connecting boss located on the rear parts on the lower sides of the left and right side plates and joined to the rear ends of the left and right side plates and the lower plate and the front end of the rear plate by welding; a bucket connecting boss joined to the front ends of the left and right side plates, the upper plate, and the lower plate by welding; and a pair of left and right bucket cylinder brackets joined to an outer surface of the upper plate by welding.

A feature of the present invention is that the upper plate is formed by joining two members, that is, a rear thick upper plate located on the rear side and made of a plate material having a large plate thickness and a front thin upper plate located on the front side of the rear thick upper plate and made of a plate material having a small plate thickness; and each of the bucket cylinder brackets is joined to an outer surface of the rear thick upper plate.

With this arrangement, the rear side requiring large strength in the upper plate constituting the arm can be composed by the rear thick upper plate having a large plate thickness and the front side not requiring large strength compared with the rear side can be formed of the front thin upper plate having a small plate thickness. As a result, the required strength can be ensured by the rear thick upper plate on the rear side of the arm, while weight reduction can be realized by the front thin upper plate on the front side of the arm. As a result, weight reduction of the entire arm can be realized while required strength is kept as compared with a case in which the upper plate is formed by using a single plate material having a uniform plate thickness.

(2) A feature of the present invention is that the lower plate is formed by joining two members, that is, a rear thick lower plate located on the rear side and made of a plate material having a large plate thickness and a front thin lower plate located on the front side of the rear thick lower plate and made of a plate material having a small plate thickness; and the boom connecting boss is configured to be joined to the rear end of the rear thick lower plate.

With this arrangement, the rear side requiring large strength in the lower plate constituting the arm can be constituted by the rear thick lower plate having a large plate thickness and the front side not requiring large strength as compared with the rear side can be constituted by the front thin lower plate having a small plate thickness. As a result, required strength can be ensured by the rear thick lower plate on the rear side of the arm, while weight reduction can be realized by the front thin lower plate on the front side of the arm.

(3) A feature of the present invention is that the upper plate is formed by joining two members, that is, a rear thick upper plate located on the rear side and made of a plate material

having a large plate thickness and a front thin upper plate located on the front side of the rear thick upper plate and made of a plate material having a small plate thickness; the lower plate is formed by joining two members, that is, a rear thick lower plate located on the rear side and made of a plate material having a large plate thickness and a front thin lower plate located on the front side of the rear thick lower plate and made of a plate material having a small plate thickness; each of the bucket cylinder brackets is configured to be joined to an outer surface of the rear thick upper plate; and the boom connecting boss is configured to be joined to the rear end of the rear thick lower plate.

With this arrangement, the rear side requiring larger strength in the upper plate and the lower plate constituting the arm can be composed of the rear thick upper plate and the rear thick lower plate having large plate thicknesses and the front side not requiring large strength as compared with the rear side can be composed of the front thin upper plate and the front thin lower plate having small plate thicknesses. As a result, weight reduction of the entire arm can be realized while required strength is ensured on the rear side of the arm.

(4) A feature of the present invention is that the upper plate is formed by joining two members, that is, a rear thick upper plate located on the rear side and made of a plate material having a large plate thickness and a front thin upper plate located on the front side of the rear thick upper plate and made of a plate material having a small plate thickness; the lower plate is formed by joining two members, that is, a rear thick lower plate located on the rear side and made of a plate material having a large plate thickness and a front thin lower plate located on the front side of the rear thick lower plate and made of a plate material having a small plate thickness; the left and right side plates are formed by joining two members, that is, a rear thick side plate located on the rear side and made of a plate material having a large plate thickness and a front thin side plate located on the front side of the rear thick side plate and made of a plate material having a small plate thickness; pair of the bucket cylinder brackets is configured to be joined to an outer surface of the rear thick upper plate; the boom connecting boss is configured to be joined to the rear end of the rear thick lower plate; and a joint portion between the rear thick side plate and the front thin side plate is configured such that an upper end thereof is joined to the rear thick upper plate and a lower end is joined to the rear thick lower plate.

With this arrangement, the left and right side plates, the upper plate, and the lower plate constituting the arm can be configured to be thick on the rear side and to be thin on the front side. As a result, further weight reduction of the entire arm can be realized while required strength is kept on the rear part side of the arm. Moreover, by joining the upper end of the joint portion between rear thick side plate and the front thin side plate to the rear thick upper plate and by joining the lower end of the joint portion between the rear thick side plate and the front thin side plate to the rear thick lower plate, strength of the joint portion between the rear thick side plate and the front thin side plate can be improved, and strength of the entire arm can be improved.

(5) According to the present invention, it is configured such that an internal partition wall for reinforcement is provided between the inner surface side of the rear thick upper plate and the boom connecting boss. With this arrangement, by connecting the boom connecting boss joined to the left and right side plates, the rear end of the lower plate, and the front end of the rear plate and the rear thick upper plate to each other by the internal partition wall, strength of the rear side of the arm on which the boom connecting boss and the bucket cylinder bracket are provided can be improved.

(6) According to the present invention, the rear plate is formed as a thick rear plate using a plate material having a plate thickness equal to or larger than the rear thick upper plate and the rear thick side plates; and the thick rear plate is joined to rear ends of the left and right rear thick side plates and a rear end of the rear thick upper plate and a front end of the thick rear plate is joined to the boom connecting boss. With this arrangement, by joining a front end of the thick rear plate having a plate thickness equal to or larger than the rear thick upper plate and the left and right rear thick side plates to the boom connecting boss, strength of the rear part side of the arm can be further improved.

(7) According to the present invention, a groove extending in the upper-and-lower direction is provided each in a front end of the rear thick side plate and a rear end of the front thin side plate by cutting away without a root face; a V-shaped groove without a root face or a gap is formed by having the groove of the rear thick side plate and the groove of the front thin side plate abut each other; and a welding bead is formed by applying welding between the rear thick side plate and the front thin side plate at the position of the V-shaped groove.

With this arrangement, by performing butt welding at the position of the V-shaped groove where the front end of the rear thick side plate and the rear end of the front thin side plate abut each other, perfect welding in which the rear thick side plate and the front thin side plate are blended over the entire region of the plate thickness can be obtained. As a result, joint strength between the rear thick side plate and the front thin side plate can be improved, and strength and durability of the entire arm can be improved.

Moreover, by forming the V-shaped groove without a root face or a gap at the abutted portion between the rear thick side plate and the front thin side plate, perfect welding can be performed on the abutted portion between the rear thick side plate and the front thin side plate without arranging a backing material on the back side of the V-shaped groove. Therefore, workability when butt welding is performed between the rear thick side plate and the front thin side plate can be improved.

(8) According to the present invention, in the bucket connecting boss, each of flange portions located on the both left and right sides of a cylindrical boss portion and extending toward the left and right side plates is provided; a groove extending in the upper-and-lower direction is provided on the front ends of the left and right side plates, respectively by cutting away without a root face; a groove extending in the upper-and-lower direction is provided on the rear ends of the left and right flange portions of the bucket connecting boss, respectively by cutting away without a root face; and each of V-shaped grooves without a root face or a gap, respectively, is formed by abutting the grooves of the left and right side plates and the grooves of the left and right flange portions, and each of welding beads is formed by applying welding between the left and right side plates and the left and right flange portions at the position of the V-shaped grooves.

(9) According to the present invention, a groove extending in the left-and-right direction is provided on the front end of the rear thick upper plate and the rear end of the front thin upper plate, respectively by cutting away without a root face; a V-shaped groove without a root face or a gap is formed by abutting the groove of the rear thick upper plate and the groove of the front thin upper plate; and a welding bead is formed by applying welding between the rear thick upper plate and the front thin upper plate at the position of the V-shaped groove.

(10) According to the present invention, a groove extending in the left-and-right direction is provided on the front end of the rear thick lower plate and the rear end of the front thin lower plate, respectively by cutting away without a root face; a V-shaped groove without a root face or a gap is formed by abutting the groove of the rear thick lower plate and the groove of the front thin lower plate; and a welding bead is formed by applying welding between the rear thick lower plate and the front thin lower plate at the position of the V-shaped groove.

(11) According to the present invention, a groove angle of the V-shaped groove is configured to be set within a range of 43 degrees or more and 90 degrees or less. According to this configuration, when the two members are subjected to butt welding using means such as arc welding or the like, heat of the arc can be sufficiently supplied to the groove of one member and the groove of the other member abutted to each other, and the two members can be blended over the entire region of the plate thickness. Moreover, by setting the groove angle of the V-shaped groove at the abutted portion of the two members at 90 degrees or less, the inside of this V-shaped groove can be filled with molten metal without excess or shortage, and a welding bead continuing smoothly between the two members can be formed.

(12) According to the present invention, an auxiliary welding member having a flat plate shape is provided on an outer surface of the rear part side of the upper plate so as to surround a welded portion between the pair of left and right bucket cylinder brackets and the upper plate; and a welding bead is formed by applying fillet welding around the auxiliary welding member.

With this arrangement, by providing the auxiliary welding member, a plate thickness of a portion in the upper plate where each bucket cylinder bracket is joined can be made partially thick. As a result, large deformation of an upper plate or each bucket cylinder bracket caused by load acting on each bucket cylinder bracket can be suppressed, and durability of the entire arm can be improved. Moreover, by applying fillet welding to the periphery of the auxiliary welding member, a welded portion between each bucket cylinder bracket and the upper plate can be reinforced by a welding bead formed between the auxiliary welding member and the upper plate. Thus, stress generated in a welded portion between each bucket cylinder bracket and the upper plate can be reduced. As a result, strength of the upper plate and each bucket cylinder bracket can be improved without increasing the plate thickness of the upper plate or each bucket cylinder bracket, and weight reduction of the entire arm can be realized while required strength is ensured.

(13) According to the present invention, an internal partition wall for reinforcement is provided between the boom connecting boss and a position on the inner surface side of the upper plate and on the front side of a position of a connecting pin provided on each of the bucket cylinder brackets; and the rear end of the auxiliary welding member is configured to be extended to the rear side of the upper end position of the internal partition wall. As a result, deformation of the upper plate as if sinking to the inner surface side by receiving load can be suppressed by the internal partition wall.

(14) According to the present invention, a gap generated between each of the bucket cylinder brackets and the auxiliary welding member on the outer surface of the upper plate is configured to be embedded by a welding bead of each of the bucket cylinder brackets and a welding bead of the auxiliary welding member. As a result, the welding bead formed between the bucket cylinder bracket and the upper plate and the welding bead formed between the auxiliary welding member and the upper plate can be integrated. As a result, joint strength of the bucket cylinder bracket to the upper plate can be improved.

(15) According to the present invention, the auxiliary welding member is formed having the M-shape on a plan view; and a notched portion notched having a rearward recessed shape is provided on the front part side of the M-shaped auxiliary welding member. With this arrangement, by applying fillet welding to the periphery of the auxiliary welding member, weld length can be ensured large. As a result, joint strength of the auxiliary welding member to the upper plate can be improved, and strength of the welded portion between the upper plate reinforced by this auxiliary welding member and the bucket cylinder bracket can be further improved.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a front view illustrating a hydraulic excavator as a construction machine provided with an arm according to the present invention.

FIG. **2** is a front view illustrating the arm as a single unit.

FIG. **3** is a plan view of the arm seen from an arrow III-III direction in FIG. **2**.

FIG. **4** is a sectional view of the arm seen from an arrow IV-IV direction in FIG. **3**.

FIG. **5** is an enlarged sectional view illustrating a rear thick upper plate, a front thin upper plate, a rear thick lower plate, a front thin lower plate, and a thick rear plate in FIG. **4**.

FIG. **6** is a sectional view of left and right side plates, the rear thick upper plate, and the rear thick lower plate seen from an arrow VI-VI direction in FIG. **5**.

FIG. **7** is a perspective view illustrating an inside of the arm in a state where the right side plate is removed.

FIG. **8** is an exploded perspective view illustrating a side plate, an upper plate, a lower plate, a rear plate, a boom connecting boss, an arm cylinder bracket, and a bucket cylinder bracket constituting the arm in an exploded state.

FIG. **9** is a sectional view of a joint portion between the rear thick side plate and the front thin side plate seen from an arrow IX-IX direction in FIG. **5**.

FIG. **10** is a sectional view illustrating a groove of the rear thick side plate and a groove of the front thin side plate.

FIG. **11** is a sectional view illustrating a V-shaped groove formed by the groove of the rear thick side plate and the groove of the front thin side plate.

FIG. **12** is a sectional view illustrating a state where the rear thick side plate and the front thin side plate are abutted to each other and welded at the position of the V-shaped groove.

FIG. **13** is a sectional view of a joint portion between the front thin side plate and the bucket connecting boss seen from an arrow XIII-XIII direction in FIG. **2**.

FIG. **14** is a sectional view illustrating a groove of the front thin side plate and a groove of a flange portion of the bucket connecting boss.

FIG. **15** is a sectional view illustrating a V-shaped groove formed by the groove of the front thin side plate and the groove of the flange portion of the bucket connecting boss.

FIG. **16** is a sectional view illustrating a state of butt welding of the front thin side plate and the flange portion of the bucket connecting boss at the position of the V-shaped groove.

FIG. **17** is a sectional view illustrating a joint portion between the rear thick upper plate and the front thin upper plate.

FIG. **18** is a sectional view illustrating a groove of the rear thick upper plate and the groove of the front thin upper plate.

FIG. **19** is a sectional view illustrating a V-shaped groove formed by the groove of the rear thick upper plate and the groove of the front thin upper plate.

FIG. **20** is a sectional view illustrating a state of butt welding of the rear thick upper plate and the front thin upper plate at the position of the V-shaped groove.

FIG. **21** is a sectional view illustrating a joint portion between the rear thick lower plate and the front thin lower plate.

FIG. **22** is a sectional view illustrating a groove of the rear thick lower plate and a groove of the front thin lower plate.

FIG. **23** is a sectional view illustrating a V-shaped groove formed by the groove of the rear thick lower plate and the groove of the front thin lower plate.

FIG. **24** is a sectional view illustrating a state of butt welding of the rear thick lower plate and the front thin lower plate at the position of the V-shaped groove.

FIG. **25** is an enlarged view of an essential part illustrating the upper plate, the bucket cylinder bracket, and the auxiliary welding member in FIG. **3** in an enlarged manner.

FIG. **26** is a sectional view of the upper plate, the bucket cylinder bracket, and a welded portion of the auxiliary welding member seen from an arrow XXVI-XXVI direction in FIG. **25**.

FIG. **27** is a sectional view illustrating a state where the auxiliary welding member is arranged in the vicinity of the welded portion between the upper plate and the bucket cylinder bracket.

FIG. **28** is a sectional view illustrating a state where a welding bead between the upper plate and the bucket cylinder bracket and the auxiliary welding member are welded.

FIG. **29** is an enlarged view of an essential part similar to FIG. **25** illustrating a modification of the auxiliary welding member.

MODE FOR CARRYING OUT THE INVENTION

An embodiment of an arm for a construction machine according to the present invention will be described below in detail with reference to the accompanying drawings by taking a case in which the construction machine is applied to an arm of a hydraulic excavator as an example.

Designated at **1** is a hydraulic excavator as a typical example of a construction in the figure. The hydraulic excavator **1** is provided with an automotive crawler-type lower traveling structure **2** and an upper revolving structure **3** rotatably mounted on the lower traveling structure **2**. A working mechanism **4** is provided capable of upward/downward movement on the front part side of a revolving frame **3**A which becomes a base of the upper revolving structure **3**.

The working mechanism **4** is provided with a boom **5** having a base end portion pin-connected to the front side of the revolving frame **3**A capable of upward/downward movement, an arm **11** which will be described later and has a base end portion rotatably pin-connected to a distal end portion of the boom **5**, a bucket **6** rotatably pin-connected to a distal end portion of the arm **11**, and a bucket link **7** provided between the distal end side of the arm **11** and the bucket **6**. Moreover, the working mechanism **4** is provided with a boom cylinder **8** for moving upward/downward the boom **5** with respect to the revolving frame **3**A, an arm cylinder **9** for rotating the arm **11** with respect to the boom **5**, and a bucket cylinder **10** for rotating the bucket **6** with respect to the arm **11**.

Here, the bucket link **7** is composed of a rear link **7**A having one end side connected to the distal end side of the arm **11** and a front link **7**B having one end side connected to the other end side of the rear link **7**A and the other end side connected to the bucket **6**. On the other hand, the bottom side of the bucket cylinder **10** is mounted to a bucket cylinder bracket **23** of the arm **11** which will be described later by using a connecting pin **10**A. The rod side of the bucket cylinder **10** is connected to a connection portion between the rear link **7**A and the front link **7**B of the bucket link **7** by using a connecting pin **10**B.

Next, the arm according to this embodiment will be described by referring to FIGS. **2** to **8**.

Designated at **11** is the arm rotatably mounted on the distal end portion of the boom **5**. This arm **11** is formed as a lengthy box-shaped structural body extending in the fore-and-rear direction as a whole and is rotated in the upper-and-lower direction by the arm cylinder **9** with respect to the boom **5**.

Here, the arm **11** is formed of left and right side plates **12** and **13**, an upper plate **14**, a lower plate **15**, and a thick rear plate **16** which will be described later, and the arm **11** has a box-shaped structural body having a cross sectional surface with a square closed sectional structure as a whole. On the rear side (boom **5** side) of the arm **11**, a boom connecting boss **18**, an arm cylinder bracket **22**, the bucket cylinder bracket **23** and the like which will be described later are provided. On the other hand, on the front side (bucket **6** side) of the arm **11**, a bucket connecting boss **20**, a rear link connecting boss **21** and the like which will be described later are provided.

Designated at **12** is a left side plate constituting a left side surface of the arm **11**. The left side plate **12** extends in the fore-and-rear direction while facing a right side plate **13** which will be described later in the left-and-right direction. Here, as illustrated in FIGS. **4** and **8**, the left side plate **12** is formed by joining two members, that is, a rear thick side plate **12**A located on the rear side in the fore-and-rear direction and a front thin side plate **12**B located on the front side in the fore-and-rear direction. The boom connecting boss **18** which will be described later is fixed to the rear thick side plate **12**A, and the bucket connecting boss **20**, the rear link connecting boss **21** which will be described later are fixed to the front thin side plate **12**B.

The rear thick side plate **12**A is formed by using a plate material such as a steel plate having a large plate thickness and has a hexagonal shape surrounded by an upper plate joining part **12A1**, a lower plate joining part **12A2**, a rear plate joining part **12A3**, and a front thin side plate joining part **12A4**. In this case, the front thin side plate joining part **12A4** is configured to ensure a large length of a joint portion between the rear thick side plate **12**A and the front thin side plate **12**B by extending diagonally forward from the upper plate joining part **12A1** to the lower plate joining part **12A2**. A corner portion where the lower plate joining part **12A2** and the rear plate joining part **12A3** intersect each other, a boom connecting boss joining groove **12A5** cut out in an arc shape is provided for joining a flange portion **18**B of the boom connecting boss **18**.

On the front end of the rear thick side plate **12**A, a groove **12A6** is provided, and the groove **12A6** is abutted to a rear side groove **12B6** of the front thin side plate **12**B which will be described later. Here, as illustrated in FIGS. **9** to **12**, the groove **12A6** is formed by cutting out an end edge of the front thin side plate joining part **12A4** constituting the rear thick side plate **12**A with inclination toward the outer surface side. This groove **12A6** is formed as a uniform inclined surface without a root face and is provided over the entire region of the front thin side plate joining part **12A4**.

On the other hand, the front thin side plate **12**B is formed by using a plate material such as a steel plate having a plate thickness smaller than that of the rear thick side plate **12**A and has a square shape surrounded by an upper plate joining part **12B1**, a lower plate joining part **12B2**, a bucket connecting

boss joining part **12**B**3**, and a rear thick side plate joining part **12**B**4**. In this case, the rear thick side plate joining part **12**B**4** extends diagonally forward from the upper plate joining part **12**B**1** to the lower plate joining part **12**B**2**. On the front end side of the front thin side plate **12**B, a rear link connecting boss joining hole **12**B**5** made of a circular hole for joining a flange portion **21**B of the rear link connecting boss **21** is provided.

On the rear end of the front thin side plate **12**B, the rear side groove **12**B**6** is provided, and the rear side groove **12**B**6** is abutted to the groove **12**A**6** of the rear thick side plate **12**A. Here, as illustrated in FIGS. **9** to **12**, the rear end groove **12**B**6** is formed by cutting out an end edge of the rear thick side plate joining part **12**B**4** constituting the front thin side plate **12**B with inclination toward the outer surface side. This groove **12**B**6** is formed as a uniform inclined surface without a root face and is provided over the entire region of the rear thick side plate joining part **12**B**4**.

On the front end of the front thin side plate **12**B, a front side groove **12**B**7** is provided, and the front side groove **12**B**7** is abutted to a groove **20**B**1** provided on a left flange portion **20**B of the bucket connecting boss **20** which will be described later. Here, as illustrated in FIGS. **13** to **16**, the front side groove **12**B**7** is formed as a uniform inclined surface without a root face by cutting out an end edge portion of the bucket connecting boss joining part **12**B**3** constituting the front thin side plate **12**B with inclination toward the inner surface side.

On the other hand, as illustrated in FIGS. **6** and **9**, assuming that a plate thickness of the rear thick side plate **12**A constituting the left side plate **12** is **12**At and a plate thickness of the front thin side plate **12**B is **12**Bt, a relationship between the plate thickness **12**At and the plate thickness **12**Bt is set as in the following formula 1:

$$12At > 12Bt \quad \text{[Formula 1]}$$

Here, as illustrated in FIG. **11**, by abutting the groove **12**A**6** of the rear thick side plate **12**A and the rear side groove **12**B**6** of the front thin side plate **12**B to each other without a gap, an inner surface of the rear thick side plate **12**A and an inner surface of the front thin side plate **12**B form the same plane without a step. On the other hand, an outer surface of the rear thick side plate **12**A and an outer surface of the front thin side plate **12**B form a step according to a difference in plate thickness, and in this stepped portion, a V-shaped groove **12**C without a root face or a gap is formed. In this case, by setting a groove angle of the V-shaped groove **12**C to θ, this groove angle θ is set within a range of the following formula 2:

$$43° \leq \theta \leq 90° \quad \text{[Formula 2]}$$

Then, as illustrated in FIG. **12**, by performing butt welding at the position of the V-shaped groove **12**C by using a welding torch **100** and the like, the front thin side plate joining part **12**A**4** of the rear thick side plate **12**A and the rear thick side plate joining part **12**B**4** of the front thin side plate **12**B are joined in a perfect welding state, and the left side plate **12** made of the rear thick side plate **12**A and the front thin side plate **12**B is formed.

Here, an opening width of the V-shaped groove **12**C is determined in accordance with an outer diameter dimension of the welding torch **100**. Moreover, the groove angle θ of the V-shaped groove **12**C is determined on the basis of the outer diameter dimension of the welding torch **100**, the plate thickness **12**At of the rear thick side plate **12**A and the plate thickness **12**Bt of the front thin side plate **12**B, and an amount of required welding bead. In this case, if the groove angle θ is too small, the rear thick side plate **12**A and the front thin side plate **12**B do not sufficiently blend, while if the groove angle θ is too large, the amount of bead to be used increases and welding workability lowers, and thus, the groove angle θ is preferably set within a range of the above-described formula 2. It should be noted that the groove angles θ of the V-shaped grooves **13**C, **14**C, **15**C, **20**D, and **20**E which will be described later are also set within the range of the above-described formula 2 similarly to the groove angle θ of the V-shaped groove **12**C.

Designated at **13** is a right side plate constituting a right side surface of the arm **11**, and the right side plate **13** has the same shape as that of the left side plate **12**. Namely, the right side plate **13** is formed by joining two members, that is, a rear thick side plate **13**A located on the rear side in the fore-and-rear direction and a front thin side plate **13**B located on the front side in the fore-and-rear direction. To the rear thick side plate **13**A, the boom connecting boss **18** which will be described later is fixed, while to the front thin side plate **13**B, the bucket connecting boss **20** and the rear link connecting boss **21**, which will be described later are fixed.

The rear thick side plate **13**A is formed by using a plate material such as a steel plate having a large plate thickness and has a hexagonal shape surrounded by an upper plate joining part **13**A**1**, a lower plate joining part **13**A**2**, a rear plate joining part **13**A**3**, and a front thin side plate joining part **13**A**4**. At a corner portion where the lower plate joining part **13**A**2** and the rear plate joining part **13**A**3** intersect each other, a boom connecting boss joining groove **13**A**5** cut out in an arc shape is provided.

On the front end of the rear thick side plate **13**A, a groove **13**A**6** is provided, and the groove **13**A**6** is abutted to a rear side groove **13**B**6** of the front thin side plate **13**B which will be described later. Here, as illustrated in FIGS. **9** to **12**, the groove **13**A**6** is formed as a uniform inclined surface without a root face by cutting out an end edge of the front thin side plate joining part **13**A**4** constituting the rear thick side plate **13**A with inclination toward the outer surface side.

On the other hand, the front thin side plate **13**B is formed by using a plate material such as a steel plate having a plate thickness smaller than that of the rear thick side plate **13**A and has a square shape surrounded by an upper plate joining part **13**B**1**, a lower plate joining part **13**B**2**, a bucket connecting boss joining part **13**B**3**, and a rear thick side plate joining part **13**B**4**. On the front end side of the front thin side plate **13**B, a rear link connecting boss joining hole **13**B**5** made of a circular hole is provided.

On the rear end of the front thin side plate **13**B, the rear side groove **13**B**6** is provided, and the rear side groove **13**B**6** is abutted to the groove **13**A**6** of the rear thick side plate **13**A. Here, as illustrated in FIGS. **9** to **12**, the rear side groove **13**B**6** is formed as a uniform inclined surface without a root face by cutting out an end edge of the rear thick side plate joining part **13134** constituting the front thin side plate **13**B with inclination toward the outer surface side.

On the front end of the front thin side plate **13**B, a front side groove **13**B**7** is provided, and the front side groove **13**B**7** is abutted to a groove **20**C**1** provided on a right flange portion **20**C of the bucket connecting boss **20** which will be described later. Here, as illustrated in FIGS. **13** to **16**, the front side groove **13**B**7** is formed as a uniform inclined surface without a root face by cutting out an end edge of the bucket connecting boss joining part **13**B**3** constituting the front thin side plate **13**B with inclination toward the inner surface side.

On the other hand, as illustrated in FIGS. **6** and **9**, assuming that a plate thickness of the rear thick side plate **13**A constituting the right side plate **13** is **13**At and a plate thickness of

the front thin side plate **13**B is **13**Bt, a relationship between the plate thickness **13**At and the plate thickness **13**Bt is set as in the following formula 3:

$$13At>13Bt \quad \text{[Formula 3]}$$

As illustrated in FIG. **11**, by abutting the groove **13**A**6** of the rear thick side plate **13**A and the rear side groove **13**B**6** of the front thin side plate **13**B to each other without a gap, an inner surface of the rear thick side plate **13**A and an inner surface of the front thin side plate **13**B form the same plane without a step. On the other hand, an outer surface of the rear thick side plate **13**A and an outer surface of the front thin side plate **13**B form a step according to a difference in plate thickness, and in this stepped portion, a V-shaped groove **13**C having a groove angle θ without a root face or a gap is formed.

As illustrated in FIG. **12**, butt welding is performed at the position of the V-shaped groove **13**C by using the welding torch **100** and the like. As a result, the front thin side plate joining part **13**A**4** of the rear thick side plate **13**A and the rear thick side plate joining part **13**B**4** of the front thin side plate **13**B are joined in a perfect welding state, and the right side plate **13** made of the rear thick side plate **13**A and the front thin side plate **13**B is formed.

Subsequently, designated at **14** is an upper plate constituting an upper surface of the arm **11**. This upper plate **14** is joined to the upper end sides of the left and right side plates **12** and **13** and extends in the fore-and-rear direction. Here, the upper plate **14** is formed by joining two members, that is, a rear thick upper plate **14**A located on the rear side of the fore-and-rear direction and a front thin upper plate **14**B located on the front side of the fore-and-rear direction. To the rear thick upper plate **14**A, the bucket cylinder bracket **23** which will be described later is fixed.

The rear thick upper plate **14**A is formed having a rectangular plate shape extending in the fore-and-rear direction by using a plate material such as a steel plate having a large plate thickness and the like, and a portion on the rear side of the bucket cylinder bracket **23** is slightly bent diagonally downward. A rear end edge of the rear thick upper plate **14**A becomes a rear plate joining part **14**A**1** to be joined to the thick rear plate **16** which will be described later, and a front end edge of the rear thick upper plate **14**A becomes a front thin upper plate joining part **14**A**2** to be joined to the front thin upper plate **14**B. Moreover, to an outer surface **14**A**4** of the rear thick upper plate **14**A, the bucket cylinder bracket **23** which will be described later is joined, and to an inner surface **14**A**5** of the rear thick upper plate **14**A, an upper end **19**A of an internal partition wall **19** which will be described later is joined.

On the front end of the rear thick upper plate **14**A, a groove **14**A**3** is provided, and the groove **14**A**3** is abutted to a groove **14**B**3** of the front thin upper plate **14**B which will be described later. Here, as illustrated in FIGS. **17** to **20**, the groove **14**A**3** is formed as a uniform inclined surface without a root face by cutting out an end edge of the front thin upper plate joining part **14**A**2** constituting the rear thick upper plate **14**A with inclination toward the outer surface **14**A**4** side.

On the other hand, the front thin upper plate **14**B is formed having a rectangular plate shape extending in the fore-and-rear direction by using a plate material such as a steel plate having a plate thickness smaller than that of the rear thick upper plate **14**A. A rear end edge of the front thin upper plate **14**B becomes a rear thick upper plate joining part **14**B**1** and a front end edge of the front thin upper plate **14**B becomes a bucket connecting boss joining part **14**B**2** to be joined to the bucket connecting boss **20** which will be described later.

On the rear end of the front thin upper plate **14**B, a groove **14**B**3** is provided, and the groove **14**B**3** is abutted to the groove **14**A**3** of the rear thick upper plate **14**A. Here, as illustrated in FIGS. **17** to **20**, the groove **14**B**3** is formed as a uniform inclined surface without a root face by cutting out an end edge of the rear thick upper plate joining part **14**B**1** constituting the front thin upper plate **14**B with inclination toward the outer surface side.

On the other hand, as illustrated in FIGS. **5** and **17**, assuming that a plate thickness of the rear thick upper plate **14**A constituting the upper plate **14** is **14**At and a plate thickness of the front thin upper plate **14**B is **14**Bt, a relationship between the plate thickness **14**At and the plate thickness **14**Bt is set as in the following formula 4:

$$14At>14Bt \quad \text{[Formula 4]}$$

As illustrated in FIG. **19**, by abutting the groove **14**A**3** of the rear thick upper plate **14**A and the groove **14**B**3** of the front thin upper plate **14**B to each other without a gap, the inner surface **14**A**5** of the rear thick upper plate **14**A and an inner surface of the front thin upper plate **14**B form the same plane without a step. On the other hand, the outer surface **14**A**4** of the rear thick upper plate **14**A and an outer surface of the front thin upper plate **14**B form a step according to a difference in plate thickness, and in this stepped portion, a V-shaped groove **14**C having a groove angle θ without a root face or a gap is formed.

As illustrated in FIG. **20**, butt welding is performed at the position of the V-shaped groove **14**C by using the welding torch **100** and the like. As a result, the front thin upper plate joining part **14**A**2** of the rear thick upper plate **14**A and the rear thick upper plate joining part **14**B**1** of the front thin upper plate **14**B are joined in a perfect welding state, and the upper plate **14** made of the rear thick upper plate **14**A and the front thin upper plate **14**B is formed.

Subsequently, designated at **15** is a lower plate constituting a lower surface of the arm **11**. This lower plate **15** is joined to the lower end sides of the left and right side plates **12** and **13** and extends in the fore-and-rear direction. Here, the lower plate **15** is formed by joining two members, that is, a rear thick lower plate **15**A located on the rear side of the fore-and-rear direction and a front thin lower plate **15**B located on the front side of the fore-and-rear direction.

The rear thick lower plate **15**A is formed having a rectangular plate shape extending in the fore-and-rear direction by using a plate material such as a steel plate having a large plate thickness and the like. A rear end edge of the rear thick lower plate **15**A becomes a boom connecting boss joining part **15**A**1** to be joined to the boom connecting boss **18** which will be described later. A front end edge of the rear thick lower plate **15**A becomes a front thin lower plate joining part **15**A**2** to be joined to the front thin lower plate **15**B.

On the front end of the rear thick lower plate **15**A, a groove **15**A**3** is provided, and the groove **15**A**3** is abutted to a groove **15**B**3** of the front thin lower plate **15**B which will be described later. Here, as illustrated in FIGS. **21** to **24**, the groove **15**A**3** is formed as a uniform inclined surface without a root face by cutting out an end edge of the front thin lower plate joining part **15**A**2** constituting the rear thick lower plate **15**A with inclination toward the outer surface side.

On the other hand, the front thin lower plate **15**B is formed having a rectangular plate shape extending in the fore-and-rear direction by using a plate material such as a steel plate having a plate thickness smaller than that of the rear thick lower plate **15**A. A rear end edge of the front thin lower plate **15**B becomes a rear thick lower plate joining part **15**B**1**. A front end edge of the front thin lower plate **15**B becomes a

bucket connecting boss joining part **15B2** to be joined to the bucket connecting boss **20** which will be described later.

On the rear end of the front thin lower plate **15**B, a groove **15B3** is provided, and the groove **15B3** is abutted to the groove **15A3** of the rear thick lower plate **15**A. Here, as illustrated in FIGS. **21** to **24**, the groove **15B3** is formed as a uniform inclined surface without a root face by cutting out an end edge of the rear thick lower plate joining part **15B1** constituting the front thin lower plate **15**B with inclination toward the outer surface side.

On the other hand, as illustrated in FIGS. **5** and **21**, assuming that a plate thickness of the rear thick lower plate **15**A constituting the lower plate **15** is **15**At and a plate thickness of the front thin lower plate **15**B is **15**Bt, a relationship between the plate thickness **15**At and the plate thickness **15**Bt is set as in the following formula 5:

$$15At>15Bt \quad \text{[Formula 5]}$$

As illustrated in FIG. **23**, by abutting the groove **15A3** of the rear thick lower plate **15**A and the groove **15B3** of the front thin lower plate **15**B to each other without a gap, an inner surface of the rear thick lower plate **15**A and an inner surface of the front thin lower plate **15**B form the same plane without a step. On the other hand, an outer surface of the rear thick lower plate **15**A and an outer surface of the front thin lower plate **15**B form a step according to a difference in plate thickness, and in this stepped portion, a V-shaped groove **15**C having a groove angle θ without a root face or a gap is formed.

As illustrated in FIG. **24**, butt welding is performed at the position of the V-shaped groove **15**C by using the welding torch **100** and the like. As a result, the front thin lower plate joining part **15A2** of the rear thick lower plate **15**A and the rear thick lower plate joining part **15B1** of the front thin lower plate **15**B are joined in a perfect welding state, and the lower plate **15** made of the rear thick lower plate **15**A and the front thin lower plate **15**B is formed.

Subsequently, designated at **16** is a thick rear plate as a rear plate constituting a rear surface of the arm **11**. This thick rear plate **16** is formed having a rectangular plate shape using a plate material such as a steel plate and the like, and a center part in the length direction is bent in a mountain shape (See FIG. **5**). A plate thickness **16***t* of this thick rear plate **16** is equal to or larger than the plate thickness **12**At of the rear thick side plate **12**A constituting the left side plate **12**, the plate thickness **13**At of the rear thick side plate **13**A constituting the right side plate **13**, the plate thickness **14**At of the rear thick upper plate **14**A constituting the upper plate **14**, and the plate thickness **15**At of the rear thick lower plate **15**A constituting the lower plate **15** and they are set as in the following formula 6:

$$16t\geq 12At,13At,14At,15At \quad \text{[Formula 6]}$$

Here, the thick rear plate **16** is joined to the rear end sides of the left and right side plates **12** and **13** and the upper plate **14** by welding and closes the rear end of the hollow arm **11**. In this case, the thick rear plate **16** is joined to the rear plate joining part **12A3** of the rear thick side plate **12**A constituting the left side plate **12**, the rear plate joining part **13A3** of the rear thick side plate **13**A constituting the right side plate **13**, and the rear plate joining part **14A1** of the rear thick upper plate **14**A constituting the upper plate **14** by welding. The front end edge of the thick rear plate **16** becomes a boom connecting boss joining part **16**A to be joined to the boom connecting boss **18** which will be described later. The arm cylinder bracket **22** which will be described later is configured to be fixed to an outer surface of the thick rear plate **16**.

Fillet welding is applied between the upper plate joining part **12A1** of the rear thick side plate **12**A constituting the left side plate **12** and the upper plate **14**. Similarly, fillet welding is applied between the upper plate joining part **12B1** of the front thin side plate **12**B and the upper plate **14**. On the other hand, fillet welding is applied between the upper plate joining part **13A1** of the rear thick side plate **13**A constituting the right side plate **13** and the upper plate **14**. Similarly, fillet welding is applied between the upper plate joining part **13B1** of the front thin side plate **13**B and the upper plate **14**. As a result, the upper plate **14** is firmly joined to the upper ends of the left and right side plates **12** and **13**.

Moreover, fillet welding is applied between the lower plate joining part **12A2** of the rear thick side plate **12**A constituting the left side plate **12** and the lower plate **15**. Similarly, fillet welding is applied between the lower plate joining part **12B2** of the front thin side plate **12**B and the lower plate **15**. On the other hand, fillet welding is applied between the lower plate joining part **13A2** of the rear thick side plate **13**A constituting the right side plate **13** and the lower plate **15**. Similarly, fillet welding is applied between the lower plate joining part **13B2** of the front thin side plate **13**B and the lower plate **15**. As a result, the lower plate **15** is firmly joined to the lower ends of the left and right side plates **12** and **13**.

Moreover, fillet welding is applied between the rear plate joining part **12A3** of the rear thick side plate **12**A constituting the left side plate **12** and the thick rear plate **16**. Similarly, fillet welding is applied between the rear plate joining part **13A3** of the rear thick sideplate **13**A constituting the right side plate **13** and the thick rear plate **16**. Moreover, fillet welding is applied between the rear plate joining part **14A1** of the rear thick upper plate **14**A constituting the upper plate **14** and the thick rear plate **16**. As a result, the thick rear plate **16** is firmly joined to the rear end sides of the left and right side plates **12** and **13** and the upper plate **14**.

Here, as illustrated in FIGS. **4** and **5**, an upper end **12**D of a joint portion between the rear thick side plate **12**A and the front thin side plate **12**B constituting the left side plate **12** is joined at a position of an intermediate portion of the rear thick upper plate **14**A, and a lower end **12**E of the joint portion is joined at a position on the front side of the rear thick lower plate **15**A. On the other hand, as illustrated in FIG. **2**, regarding the joint portion between the rear thick side plate **13**A and the front thin side plate **13**B constituting the right side plate **13**, the upper end **13**D is joined at the intermediate portion of the rear thick upper plate **14**A, and a lower end **13**E of the joint portion is joined at a position on the front part side of the rear thick lower plate **15**A.

Designated at **17** is left and right backing materials provided between the rear thick side plate **12**A of the left side plate **12** and the thick rear plate **16** and between the rear thick side plate **13**A of the right side plate **13** and the thick rear plate **16**, respectively. Each of the backing materials **17** is formed by bending an elongated square material into a mountain shape, respectively, for example, and is fixed to inner surfaces of the rear plate joining parts **12A3** and **13A3** of the rear thick side plates **12**A and **13**A by spot welding and the like, respectively.

It is configured such that a space between the rear plate joining part **12A3** of the rear thick side plate **12**A constituting the left side plate **12** and the thick rear plate **16** is fillet-welded by using the backing material **17**, and a space between the rear plate joining part **13A3** of the rear thick side plate **13**A constituting the right side plate **13** and the thick rear plate **16** is fillet-welded by using the backing material **17**. As a result, these fillet welding parts become perfect welding.

Subsequently, designated at **18** is a boom connecting boss provided on the rear parts on the lower sides of the left and right side plates **12** and **13**. A connecting pin (not shown) rotabaly connecting the boom **5** and the arm **11** is inserted into this boom connecting boss **18**. Here, the boom connecting boss **18** is composed of a hollow cylindrical boss portion **18**A extending in the left-and-right direction and left and right flange portions **18**B made of arc shaped flat plates provided on both end sides in the left-and-right direction of the cylindrical boss portion **18**A.

The cylindrical boss portion **18**A of the boom connecting boss **18** is joined to the boom connecting boss joining part **15A1** of the rear thick lower plate **15**A and to the boom connecting boss joining part **16**A of the thick rear plate **16** by welding. The left side flange portion **18**B of the boom connecting boss **18** is joined to the boom connecting boss joining groove **12A5** of the rear thick side plate **12**A, and the right side flange portion **18**B is joined to the boom connecting boss joining groove **13A5** of the rear thick side plate **13**A.

Designated at **19** is an internal partition wall provided between the inner surface of the rear thick upper plate **14**A of the upper plate **14** and the boom connecting boss **18**. This internal partition wall **19** is arranged so as to form two closed spaces in the arm **11** and improves rigidity of the arm **11**. This internal partition wall **19** is formed of a rectangular flat plate having a width dimension in the left-and-right direction substantially equal to an interval between the left and right side plates **12** and **13**.

Here, as illustrated in FIGS. **4** and **5**, the upper end **19**A of the internal partition wall **19** is joined to a position close to a joint portion between the rear thick upper plate **14**A and the front thin upper plate **14**B by welding. A lower end **19**B of the internal partition wall **19** is joined to the cylindrical boss portion **18**A of the boom connecting boss **18** by welding. Here, the upper end **19**A of the internal partition wall **19** is joined to the inner surface **14A5** of the rear thick upper plate **14**A at a position on the front side of a pin insertion hole **23**A of the bucket cylinder bracket **23** which will be described later, that is, a position on the front side of the connecting pin **10**A to which the bucket cylinder **10** is connected. On the other hand, a left side end **19**C of the internal partition wall **19** is joined to the rear thick side plate **12**A of the left side plate **12** and the front thin side plate **12**B by welding, and the right side end **19**C is joined to the rear thick side plate **13**A of the right side plate **13** and the front thin side plate **13**B by welding.

Designated at **20** is a bucket connecting boss provided on the front ends of the left and right side plates **12** and **13**, the upper plate **14** and the lower plate **15**. A connecting pin (not shown) rotatably connecting the bucket **6** and the arm **11** is inserted into the bucket connecting boss **20**. This bucket connecting boss **20** is composed of a hollow cylindrical boss portion **20**A extending in the left-and-right direction and left flange portion **20**B and a right flange portion **20**C each having a flat plate shape provided on the both end sides in the left-and-right direction of the cylindrical boss portion **20**A.

On the rear end of the left flange portion **20**B, the groove **20B1** is provided, and the groove **20B1** is abutted to the front side groove **12B7** provided on the front thin side plate **12**B. Here, as illustrated in FIGS. **13** to **16**, the groove **20B1** is formed as a uniform inclined surface without a root face by cutting out a rear end edge of the left flange portion **20**B with inclination toward the inner surface side.

In this case, the left flange portion **20**B has a plate thickness substantially equal to the plate thickness **12**Bt of the front thin side plate **12**B. Therefore, as illustrated in FIG. **15**, by abutting the front side groove **12B7** of the front thin side plate **12**B and the groove **20B1** of the left flange portion **20**B without a gap, the outer surface of the front thin side plate **12**B and an outer surface of the left flange portion **20**B form the same plane without a step. On the other hand, on the inner surface sides of the front thin side plate **12**B and the left flange portion **20**B, the V-shaped groove **20**D having a groove angle θ without a root face or a gap is formed.

As illustrated in FIG. **16**, by performing butt welding at the position of the V-shaped groove **20**D by using the welding torch **100** and the like, the bucket connecting boss joining part **12B3** of the front thin side plate **12**B and the left flange portion **20**B of the bucket connecting boss **20** are joined in a perfect welding state.

On the rear end of the right flange portion **20**C, the groove **20C1** is provided, and the groove **20C1** is to be abutted to the front side groove **13B7** provided on the front thin side plate **13**B. Here, the groove **20C1** is formed by cutting out the rear end edge of the right flange portion **20**C with inclination toward the inner surface side and is formed as a uniform inclined surface without a root face.

In this case, the right flange portion **20**C has a plate thickness substantially equal to the plate thickness **13**Bt of the front thin side plate **13**B. Therefore, by abutting the front side groove **13B7** of the front thin side plate **13**B and the groove **20C1** of the right flange portion **20**C without a gap, the outer surface of the front thin side plate **13**B and an outer surface of the right flange portion **20**C form the same plane without a step. On the other hand, on the inner surface sides of the front thin side plate **133** and the right flange portion **20**C, the V-shaped groove **20**E having a groove angle θ without a root face or a gap is formed.

By performing butt welding at the position of the V-shaped groove **20**E by using the welding torch **100** and the like, the bucket connecting boss joining part **13B3** of the front thin side plate **13**B and the right flange portion **20**C of the bucket connecting boss **20** are joined in a perfect welding state.

The cylindrical boss portion **20**A of the bucket connecting boss **20** is joined to the bucket connecting boss joining part **14B2** of the front thin upper plate **14**B constituting the upper plate **14** and to the bucket connecting boss joining part **15B2** of the front thin lower plate **15**B constituting the lower plate **15** by welding.

Designated at **21** is the rear link connecting boss provided on the front end sides of the left and right side plates **12** and **13** adjacent to the bucket connecting boss **20**. A connecting pin (not shown) rotatably connecting the rear link **7**A of the bucket link **7** and the arm **11** is inserted into this rear link connecting boss **21**. Here, the rear link connecting boss **21** is composed of a hollow cylindrical boss portion **21**A extending in the left-and-right direction and disc-shaped left and right flange portions **21**B provided on the both end sides in the left-and-right direction of the cylindrical boss portion **21**A. The left side flange portion **21**B of the rear link connecting boss **21** is joined to the rear link connecting boss joining hole **12B5** of the front thin side plate **12**B, and the right side flange portion **21**B is joined to the rear link connecting boss joining hole **13B5** of the front thin side plate **13**B.

Designated at **22** is a pair of arm cylinder brackets provided on the outer surface of the thick rear plate **16**, and each of the arm cylinder brackets **21** is arranged forming a pair in the left-and-right direction. To each of the arm cylinder brackets **22**, a rod distal end of the arm cylinder **9** is rotatably connected through a connecting pin (not shown). Here, each of the arm cylinder brackets **22** is formed having a substantially triangular plate body by using a plate material such as a steel plate and the like, and a pin insertion hole **22**A through which the above-described connecting pin is inserted is drilled in the

center part thereof. Moreover, each of the arm cylinder brackets **22** is joined to the outer surface of the thick rear plate **16** by welding in a state where a certain interval is kept in the left-and-right direction.

Designated at **23** is a pair of bucket cylinder brackets provided on the outer surface **14**A**4** of the rear thick upper plate **14**A constituting the upper plate **14**. Each of the bucket cylinder brackets **23** is arranged forming a pair in the left-and-right direction, and the bottom side of the bucket cylinder **10** is rotatably connected thereto through the connecting pin **10**A. Here, each of the bucket cylinder brackets **23** is formed as a substantially triangular plate body by using a plate material such as a steel plate and the like, and a pin insertion hole **23**A through which the above-described connecting pin **10**A is inserted is drilled on the distal end side thereof. Moreover, each of the bucket cylinder brackets **23** is joined to the outer surface **14**A**4** of the rear thick upper plate **14**A by welding in a state where a certain interval is kept in the left-and-right direction.

Subsequently, designated at **24** is an auxiliary welding member provided on the rear side of the upper plate **14**. This auxiliary welding member **24** is provided on the outer surface **14**A**4** of the rear thick upper plate **14**A so as to surround a welded portion between the rear thick upper plate **14**A of the upper plate **14** and each of the bucket cylinder brackets **23**. Here, as illustrated in FIGS. **25** and **26**, the auxiliary welding member **24** is formed as a flat plate having a substantially M-shape on a plan view from above. That is, the auxiliary welding member **24** is made of a square flat plate having a width dimension slightly smaller than a width dimension in the left-and-right direction of the rear thick upper plate **14**A as a whole. This auxiliary welding member **24** has a notched portion **24**B located in the middle of the left-and-right direction and cut out having a recessed shape rearward from a front end **24**A and a pair of groove portions **24**D extending forward from a rear end **24**C.

Here, the periphery (outer peripheral edge portion) of the auxiliary welding member **24** is fillet-welded to the outer surface **14**A**4** of the rear thick upper plate **14**A over the entire periphery. As a result, as illustrated in FIG. **26**, the plate thickness **14**At of the rear thick upper plate **14**A is superimposed with a plate thickness **24***t* of the auxiliary welding member **24** so that the plate thickness of a portion in the rear thick upper plate **14**A where the bucket cylinder bracket **23** is joined can be partially made thicker in configuration.

As illustrated in FIG. **5**, the front end **24**A of the auxiliary welding member **24** is arranged on the front side of the pin insertion hole **23**A of the bucket cylinder bracket **23**, and the rear end **24**C of the auxiliary welding member **24** is arranged on the rear side of the upper end **19**A of the internal partition wall **19**. As described above, the auxiliary welding member **24** is arranged so as to extend in the fore-and-rear direction while sandwiching the upper end **19**A of the internal partition wall **19**.

On the other hand, as illustrated in FIGS. **27** and **28**, a bracket-side welding bead **26**A constituting the welding bead **26** which will be described later is formed on a joint portion between the outer surface **14**A**4** of the rear thick upper plate **14**A and the bucket cylinder bracket **23**. Here, in a state where the groove portion **24**D of the auxiliary welding member **24** is inserted into the front part side of the bucket cylinder bracket **23**, a gap **25** is formed between the groove portion **24**D of the auxiliary welding member **24** and the bucket cylinder bracket **23**.

In this state, to the peripheral edge portion of the groove portion **24**D provided on the auxiliary welding member **24**, fillet welding is applied by using the welding torch **100**, for example. Therefore, the bracket-side welding bead **26**A formed between the bucket cylinder bracket **23** and the rear thick upper plate **14**A and an auxiliary welding member side welding bead **26**B formed between the groove portion **24**D of the auxiliary welding member **24** and the rear thick upper plate **14**A are integrated so that the welding bead **26** is formed. The gap **25** formed between the groove portion **24**D of the auxiliary welding member **24** and the bucket cylinder bracket **23** can be embedded in this welding bead **26**.

As a result, as illustrated in FIG. **26**, each of the groove portions **24**D of the auxiliary welding member **24** and each of the bucket cylinder brackets **23** can be joined together with the smoothly continuing welding bead **26**. On the other hand, by applying fillet welding to the periphery of the notched portion **24**B provided on the front end **24**A of the auxiliary welding member **24**, a welding length of the auxiliary welding member **24** with respect to the rear thick upper plate **14**A can be ensured large.

The arm **11** according to this embodiment has the configuration as described above, and an example of a procedure of manufacturing this arm **11** will be described by referring to FIG. **8**.

First, as illustrated in FIGS. **10** and **11**, the groove **12**A**6** of the rear thick side plate **12**A constituting the left side plate **12** and the rear side groove **12**B**6** of the front thin side plate **12**B are abutted to each other so as to form the V-shaped groove **12**C, and butt welding is performed by using means such as arc welding and the like at the position of this V-shaped groove **12**C. In this case, since the V-shaped groove **12**C does not have a root face or a gap, arcs from the welding torch **100** can be supplied to the whole surface of each of the grooves **12**A**6** and **12**B**6**. As a result, perfect welding can be performed such that the rear thick side plate **12**A and the front thin side plate **12**B are blended over the entire region of the plate thickness.

Moreover, since the groove angle θ of the V-shaped groove **12**C is set within a range of 43 degrees of more and 90 degrees or less, arc heat can be sufficiently supplied to each of the grooves **12**A**6** and **12**B**6**, and the inside of the V-shaped groove **12**C can be filled with molten metal without excess or shortage. Thus, as illustrated in FIG. **9**, a welding bead **12**F smoothly continuing between the rear thick side plate **12**A and the front thin side plate **12**B can be formed. As a result, the left side plate **12** in which the rear thick side plate **12**A and the front thin side plate **12**B are firmly joined can be formed without arranging a backing material and the like on the back side of the V-shaped groove **12**C.

Similarly to the above, the groove **13**A**6** of the rear thick side plate **13**A constituting the right side plate **13** and the rear side groove **13**B**6** of the front thin side plate **13**B are abutted to each other so as to form the V-shaped groove **13**C, and butt welding is performed at the position of this V-shaped groove **13**C. As a result, a welding bead **13**F smoothly continuing between the rear thick side plate **13**A and the front thin side plate **13**B can be formed, and the right side plate **13** in which the rear thick side plate **13**A and the front thin side plate **13**B are firmly joined can be formed.

Subsequently, the left and right flange portions **18**B of the boom connecting boss **18** are joined to the boom connecting boss joining groove **12**A**5** of the left side plate **12** and the boom connecting boss joining groove **13**A**5** of the right side plate **13** by welding, respectively. Moreover, the left and right flange portions **21**B of the rear link connecting boss **21** are joined to the rear link connecting boss joining hole **12**B**5** of the left side plate **12** and the rear link connecting boss joining hole **13**B**5** of the right side plate **13** by welding, respectively.

Subsequently, as illustrated in FIGS. **14** and **15**, the front side groove **12**B**7** of the front thin side plate **12**B constituting the left side plate **12** and the groove **20**B**1** of the left flange portion **20**B constituting the bucket connecting boss **20** are abutted so as to form the V-shaped groove **20**D, and butt welding is performed at the position of this V-shaped groove **20**D. As a result, a welding bead **20**F smoothly continuing between the front thin side plate **12**B and the left flange portion **20**B can be formed, and the front thin side plate **12**B and the left flange portion **20**B can be firmly joined.

On the other hand, the front side groove **13**B**7** of the front thin side plate **13**B constituting the right side plate **13** and the groove **20**C**1** of the right flange portion **20**C constituting the bucket connecting boss **20** are abutted so as to form the V-shaped groove **20**E, and butt welding is performed at the position of this V-shaped groove **20**E. As a result, a welding bead **20**G smoothly continuing between the front thin side plate **13**B and the right flange portion **20**C can be formed, and the front thin side plate **13**B and the right flange portion **20**C can be firmly joined.

Subsequently, as illustrated in FIGS. **18** and **19**, the groove **14**A**3** of the rear thick upper plate **14**A and the groove **14**B**3** of the front thin upper plate **14**B are abutted so as to form the V-shaped groove **14**C, and butt welding is performed at the position of this V-shaped groove **14**C. As a result, a welding bead **14**D smoothly continuing between the rear thick upper plate **14**A and the front thin upper plate **14**B can be formed, and the upper plate **14** in which the rear thick upper plate **14**A and the front thin upper plate **14**B are firmly joined can be formed.

Moreover, as illustrated in FIGS. **22** and **23**, the groove **15**A**3** of the rear thick lower plate **15**A and the groove **15**B**3** of the front thin lower plate **15**B are abutted so as to form the V-shaped groove **15**C, and butt welding is performed at the position of this V-shaped groove **15**C. As a result, a welding bead **15**D smoothly continuing between the rear thick lower plate **15**A and the front thin lower plate **15**B can be formed, and the lower plate **15** in which the rear thick lower plate **15**A and the front thin lower plate **15**B are firmly joined can be formed.

Subsequently, the upper plate **14** is arranged on the upper sides of the left side plate **12** and the right side plate **13**, and fillet welding is applied over the whole length between the left side plate **12** and the upper plate **14**. Similarly, fillet welding is applied over the whole length between the right side plate **13** and the upper plate **14**. Moreover, the bucket connecting boss joining part **14**B**2** of the front thin upper plate **14**B constituting the upper plate **14** is joined to the cylindrical boss portion **20**A of the bucket connecting boss **20** by welding. As a result, the upper plate **14** can be joined to the upper end sides of the left and right side plates **12** and **13**.

On the other hand, the internal partition wall **19** is prepared, and the upper end **19**A of this internal partition wall **19** is welded to a portion close to the front thin upper plate joining part **14**A**2** of the rear thick upper plate **14**A constituting the upper plate **14**. In addition, the lower end **19**B of the internal partition wall **19** is welded to the cylindrical boss portion **18**A of the boom connecting boss **18**. Moreover, the left side end **19**C of the internal partition wall **19** is welded to the inner surfaces of the rear thick side plate **12**A and the front thin side plate **12**B of the left side plate **12**, and the right side end **19**C of the internal partition wall **19** is welded to the inner surfaces of the rear thick side plate **13**A and the front thin side plate **13**B of the right side plate **13**.

Subsequently, a lower plate **15** is arranged on the lower end sides of the left side plate **12** and the right side plate **13**, and fillet welding is applied to the whole length between the left side plate **12** and the lower plate **15**. Similarly to this, fillet welding is applied to the whole length between the right side plate **13** and the lower plate **15**. On the other hand, the boom connecting boss joining part **15**A**1** of the rear thick lower plate **15**A is joined to the cylindrical boss portion **18**A of the boom connecting boss **18** by welding. Moreover, the bucket connecting boss joining part **15**B**2** of the front thin lower plate **15**B is joined to the cylindrical boss portion **20**A of the bucket connecting boss **20** by welding. As a result, the lower plate **15** can be joined to the lower end sides of the left and right side plates **12** and **13**.

The upper plate **14** is joined to the upper end sides of the left and right side plates **12** and **13** and the lower plate **15** is joined to the lower end sides, and then, the thick rear plate **16** is prepared. In a state where the backing material **17** fixed to the rear thick side plate **12**A of the left side plate **12** and the thick rear plate **16** are brought into contact with each other, fillet welding is applied between the rear plate joining part **12**A**3** of the rear thick side plate **12**A and the thick rear plate **16**. In a state where the backing material **17** fixed to the rear thick side plate **13**A of the right side plate **13** and the thick rear plate **16** are brought into contact with each other, fillet welding is applied between the rear plate joining part **13**A**3** of the rear thick side plate **13**A and the thick rear plate **16**. On the other hand, fillet welding is applied between the rear plate joining part **14**A**1** of the rear thick upper plate **14**A constituting the upper plate **14** and the thick rear plate **16**, and the boom connecting boss joining part **16**A of the thick rear plate **16** is welded to the cylindrical boss portion **18**A of the boom connecting boss **18**.

Subsequently, a pair of left and right bucket cylinder brackets **23** are joined to the outer surface of the rear thick upper plate **14**A constituting the upper plate **14** by welding. Moreover, the auxiliary welding member **24** is provided on the outer surface **14**A**4** of the rear thick upper plate **14**A so as to surround a welded portion between the rear thick upper plate **14**A and each bucket cylinder bracket **23**. In this state, an outer peripheral edge of the auxiliary welding member **24** is fillet-welded to the outer surface **14**A**4** of the rear thick upper plate **14**A over the entire periphery. As a result, as illustrated in FIG. **26**, the plate thickness **24***t* of the auxiliary welding member **24** can be superimposed with the plate thickness **14**At of the rear thick upper plate **14**A, and a plate thickness of the portion in the rear thick upper plate **14**A where the bucket cylinder bracket **23** is joined can be partially made thicker.

In this case, as illustrated in FIGS. **27** and **28**, the bracket-side welding bead **26**A is formed on a joint portion between the outer surface **14**A**4** of the rear thick upper plate **14**A and the bucket cylinder bracket **23**. On the other hand, a gap **25** is formed between the groove portion **24**D of the auxiliary welding member **24** and the bucket cylinder bracket **23**.

In this state, fillet welding is applied to the peripheral edge of the groove portion **24**D provided on the auxiliary welding member **24** by using the welding torch **100**. Therefore, the welding bead **26** in which the bracket-side welding bead **26**A formed between the bucket cylinder bracket **23** and the rear thick upper plate **14**A and the auxiliary welding member side welding bead **26**B formed between the groove portion **24**D of the auxiliary welding member **24** and the rear thick upper plate **14**A are blended can be formed. This welding bead **26** fills the gap **25** formed between the groove portion **24**D of the auxiliary welding member **24** and the bucket cylinder bracket **23**. As a result, each groove portion **24**D of the auxiliary welding member **24** and each bucket cylinder bracket **23** can be joined to each other by the smoothly continuing welding bead **26**.

Then, the arm **11** having a cross sectional surface in a square closed sectional structure can be formed by welding the left and right side plates **12** and **13**, the upper plate **14**, the lower plate **15**, the thick rear plate **16** and the like to each other.

In this case, according to this embodiment, the upper plate **14** is formed by joining the rear thick upper plate **14**A having the large plate thickness **14**At and the front thin upper plate **14**B having the small plate thickness **14**Bt by welding, and the bucket cylinder bracket **23** to which the bucket cylinder **10** is connected is joined to the outer surface of the rear thick upper plate **14**A.

As described above, the rear side in the upper plate **14** requiring large strength can be constituted by the rear thick upper plate **14**A, and the front side not requiring large strength as compared with the rear side can be constituted by the front thin upper plate **14**B. Therefore, required strength can be ensured by the rear thick upper plate **14**A on the rear side of the arm **11**, and the weight reduction can be realized by the front thin upper plate **14**B on the front side of the arm **11**. As a result, weight reduction of the entire arm **11** can be realized while required strength is ensured as compared with the case in which an upper plate is constituted by using a single plate material having a uniform plate thickness.

On the other hand, the lower plate **15** is also formed by joining the rear thick lower plate **15**A having the large plate thickness **15**At and the front thin lower plate **15**B having the small plate thickness **15**Bt by welding. Further, the left side plate **12** is also formed by joining the rear thick side plate **12**A having the large plate thickness **12**At and the front thin side plate **12**B having the small plate thickness **12**Bt by welding, and the right side plate **13** is also formed by joining the rear thick side plate **13**A having the large plate thickness **13**At and the front thin side plate **13**B having the small plate thickness **13**Bt by welding.

As a result, on the rear part side of the arm **11** where the boom connecting boss **18**, the arm cylinder bracket **22**, the bucket cylinder bracket **23** and the like are provided, required strength can be ensured by the rear thick lower plate **15**A and the left and right rear thick side plates **12**A and **13**A. On the other hand, on the front part side of the arm **11**, weight reduction can be realized by the front thin lower plate **15**B and the left and right front thin side plates **12**B and **13**B. Therefore, as compared with the case in which the lower plate and each side plate are constituted by using a single plate material having a uniform plate thickness, further weight reduction of the entire arm **11** can be realized while required strength is ensured.

Moreover, as illustrated in FIG. **4**, regarding the joint portion between the rear thick side plate **12**A and the front thin side plate **12**B of the left side plate **12**, the upper end **12**D of this joint portion is configured to be joined to the rear thick upper plate **14**A of the upper plate **14**, and the lower end **12**E of the joint portion to the rear thick lower plate **15**A of the lower plate **14**. On the other hand, as illustrated in FIG. **2**, regarding the joint portion between the rear thick side plate **13**A and the front thin side plate **13**B of the right side plate **13**, the upper end **13**D of this joint portion is configured to be joined to the rear thick upper plate **14**A of the upper plate **14**, and the lower end **13**E of the joint portion to the rear thick lower plate **15**A of the lower plate **14**.

As a result, strength of the joint portion between the rear thick side plate **12**A and the front thin side plate **12**B of the left side plate **12** can be improved and at the same time, strength of the joint portion between the rear thick side plate **13**A and the front thin side plate **13**B of the right side plate **13** can be improved, and strength of the entire arm **11** can be improved.

On the other hand, according to this embodiment, the internal partition wall **19** is configured to be provided among the left and right side plates **12** and **13**, the boom connecting boss **18**, and the upper plate **14**. As a result, two closed spaces can be formed by the internal partition wall **19** in the arm **11**, and rigidity of the entire arm **11** can be improved.

Further, according to this embodiment, the thick rear plate **16** is formed by using a plate material having a plate thickness equal to or larger than the rear thick side plates **12**A and **13**A of the left and right side plates **12** and **13**, the rear thick upper plate **14**A of the upper plate **14**, and the rear thick lower plate **15**A of the lower plate **15**. Therefore, strength of the rear end of the arm **11** on which the arm cylinder bracket **22** is provided can be further improved.

On the other hand, according to this embodiment, joining strength between the rear thick side plate **12**A and the front thin side plate **12**B can be improved by forming the V-shaped groove **12**C between the groove **12**A**6** provided on the rear thick side plate **12**A of the left side plate **12** and the rear side groove **12**B**6** provided on the front thin side plate **12**B of the left side plate **12**.

Similarly to the above, joining strength between the rear thick side plate **13**A and the front thin side plate **13**B can be improved by forming the V-shaped groove **13**C between the groove **13**A**6** provided on the rear thick side plate **13**A of the right side plate **13** and the rear side groove **13**B**6** provided on the front thin side plate **133** of the right side plate **13**.

On the other hand, the V-shaped groove **20**D is formed between the front side groove **12**B**7** of the front thin side plate **12**B and the groove **20**B**1** of the left flange portion **20**B of the bucket connecting boss **20**, and the V-shaped groove **20**E is formed between the front side groove **13**B**7** of the front thin side plate **13**B and the groove **20**C**1** of the right flange portion **20**C of the bucket connecting boss **20**. As a result, joining strength between the left side plate **12** and the left flange portion **20**B of the bucket connecting boss **20** can be improved, and joining strength between the right side plate **13** and the right flange portion **20**C of the bucket connecting boss **20** can be improved.

Further, the joining strength between the rear thick upper plate **14**A and the front thin upper plate **14**B can be improved by forming the V-shaped groove **14**C between the groove **14**A**3** provided on the rear thick upper plate **14**A of the upper plate **14** and the groove **14**B**3** provided on the front thin upper plate **14**B.

Similarly to the above, the joining strength between the rear thick lower plate **15**A and the front thin lower plate **15**B can be improved by forming the V-shaped groove **15**C between the groove **15**A**3** provided on the rear thick lower plate **15**A of the lower plate **15** and the groove **15**B**3** provided on the front thin lower plate **15**B.

On the other hand, according to this embodiment, fillet welding is applied over the entire periphery between the outer peripheral edge of the auxiliary welding member **24** and the rear thick upper plate **14**A in configuration. Therefore, the plate thickness of the portion in the rear thick upper plate **14**A where the bucket cylinder bracket **23** is joined can be made thicker only by the plate thickness of the auxiliary welding member **24**. As a result, large deformation of the rear thick upper plate **14**A and each bucket cylinder bracket **23** caused by load acting on each bucket cylinder bracket **23** can be suppressed, and durability of the entire arm **11** can be improved.

Furthermore, by applying fillet welding between the peripheral edge of the groove portion **24**D provided on the auxiliary welding member **24** and the rear thick upper plate **14**A, each groove portion **24**D of the auxiliary welding mem-

ber **24** and each bucket cylinder bracket **23** can be joined by the smoothly continuing welding bead **26**. As a result, joining strength of each bucket cylinder bracket **23** to the rear thick upper plate **14**A can be improved without increasing the plate thickness of each bucket cylinder bracket **23**.

It should be noted that in the above-described embodiment, the case using the single M-shaped auxiliary welding member **24** having the notched portion **24**B and the left and right groove portions **24**D is exemplified. However, the present invention is not limited to the same and as in a variation illustrated in FIG. **29**, for example, the auxiliary welding member **27** may be provided one each to the left and right bucket cylinder brackets **23**, that is, two members in total in configuration. This auxiliary welding member **27** is formed of a rectangular flat plate extending in the fore-and-rear direction and in a state where the bucket cylinder bracket **23** is inserted through the single groove portion **27**A extending in the fore-and-rear direction, its outer peripheral edge is fillet-welded to the outer surface **14**A**4** of the rear thick upper plate **14**A over the entire periphery.

In the above-described embodiment, as one example of the procedure of assembling the arm **11**, the boom connecting boss **18**, the bucket connecting boss **20**, and the rear link connecting boss **21** are joined to the left and right side plates **12** and **13** and then, the upper plate **14** is joined to each of the side plates **12** and **13**. Subsequently, the case when the internal partition wall **19** is joined between the upper plate **14** and the boom connecting boss **18** and then, the lower plate **15** and the thick rear plate **16** are joined to each of the side plates **12** and **13**, is exemplified. However, the assembling procedure of the arm **11** according to the present invention is not limited to the above-described embodiment, but the procedure of assembling the arm **11** can be changed as appropriate.

In the above-described embodiment, the configuration in which the backing material **17** is fixed to the rear thick side plates **12**A and **13**A constituting the left and right side plates **12** and **13**, and fillet welding is applied between each of the rear thick side plates **12**A and **13**A and the thick rear plate **16** by using this backing material **17** is exemplified. However, the present invention is not limited to the same, it may be so configured that fillet welding is applied between each of the rear thick side plates **12**A and **13**A and the thick rear plate **16** without using the backing material **17**.

Moreover, in the above-described embodiment, the crawler-type hydraulic excavator **1** is described as an example as the construction machine. However, the present invention is not limited to the same and can be widely applied to other arms for construction machine such as an arm used in a wheel-type hydraulic excavator and the like, for example.

DESCRIPTION OF REFERENCE NUMERALS

1: Hydraulic excavator (Construction machine)
10: Bucket cylinder
10A: Connecting pin
11: Arm
12: Left side plate
12A, **13**A: Rear thick side plate
12A**6**, **13**A**6**, **14**A**3**, **14**B**3**, **15**A**3**, **15**B**3**, **20**B**1**, **20**C**1**: Groove
12B, **13**B: Front thin side plate
12B**6**, **13**B**6**: Rear side groove (Groove)
12B**7**, **13**B**7**: Front side groove (Groove)
12C, **13**C, **14**C, **15**C, **20**D, **20**E: V-shaped groove
13: Right side plate
14: Upper plate
14A: Rear thick upper plate
14A**4**: Outer surface
14B: Front thin upper plate
15: Lower plate
15A: Rear thick lower plate
15B: Front thin lower plate
16: Thick rear plate
18: Boom connecting boss
19: Internal partition wall
19A: Upper end
20: Bucket connecting boss
20A: Cylindrical boss portion
20B: Left flange portion
20C: Right flange portion
23: Bucket cylinder bracket
24, **27**: Auxiliary welding member
24A: Front end
24B: Notched portion
24C: Rear end
25: Gap
26: Welding bead
26A: Bracket-side welding bead
26B: Auxiliary welding member side welding bead

The invention claimed is:

1. An arm for a construction machine formed as a box-shaped structural body having a square cross sectional surface, having left and right side plates, an upper plate joined to upper end sides of said left and right side plates by welding, a lower plate joined to lower end sides of said left and right side plates by welding, and a rear plate joined to rear end sides of said left and right side plates and a rear end side of said upper plate by welding, comprising:

a boom connecting boss located on rear parts on the lower end sides of said left and right side plates and joined to the rear end sides of said left and right side plates and said lower plate and a front end of said rear plate by welding;

a bucket connecting boss joined to front ends of said left and right side plates, said upper plate, and said lower plate by welding; and

a pair of left and right bucket cylinder brackets joined to an outer surface of said upper plate by welding , characterized in that;

said upper plate is formed by joining two members, that is, a rear, thick upper plate located on a rear side of said upper plate and made of a plate material having a large plate thickness and a front, thin upper plate located on a front side of said rear, thick upper plate and made of a plate material having a small plate thickness;

said lower plate is formed by joining two members, that is, a rear, thick lower plate located on a rear side of said lower plate and made of a plate material having a large plate thickness and a front, thin lower plate located on a front side of said rear thick lower plate and made of a plate material having a small plate thickness;

said left and right side plates are formed by joining two members, that is, a rear, thick side plate located on a rear side of each of said left and right plates and made of a plate material having a large plate thickness and a front, thin side plate located on a front side of each said rear, thick side plate and made of a plate material having a small plate thickness;

said pair of said left and right bucket cylinder brackets are configured to be joined to an outer surface of said rear, thick upper plate;

said boom connecting boss is configured to be joined to a rear end of said rear, thick lower plate;

a joint portion between said rear, thick side plate and said front, thin side plate, said joint portion being configured such that an upper end of said joint portion is joined to said rear, thick upper plate and a lower end of said joint portion is joined to said rear, thick lower plate;

an auxiliary welding member having a flat plate shape and provided on an outer surface of the rear part side of said upper plate so as to surround a welded portion between each of said pair of left and right bucket cylinder brackets and said upper plate; and

a welding bead formed by applying fillet welding around said auxiliary welding member.

2. The arm for a construction machine according to claim **1**, wherein

an internal partition wall for reinforcement is provided between an inner surface side of said rear, thick upper plate and said boom connecting boss.

3. The arm for a construction machine according to claim **1**, wherein

said rear plate is formed as a thick rear plate using a plate material having a plate thickness equal to or larger than said rear, thick upper plate and said rear, thick side plates; and

said thick rear plate is joined to rear ends of said left and right rear, thick side plates and a rear end of said rear, thick upper plate, and a front end of said thick rear plate is joined to said boom connecting boss.

4. The arm for a construction machine according to claim **1**, wherein

a groove extending in an upper-and-lower direction is provided in a front end of each of said rear, thick side plates and a rear end of each of said front, thin side plates by cutting away without a root face;

a V-shaped groove without a root face or a gap is formed by having said groove of each of said rear, thick side plates and said groove of each of said front, thin side plates abut each other; and

a welding bead is formed by applying welding between each of said rear, thick side plates and each of said front, thin side plates at a position of said V-shaped groove.

5. The arm for a construction machine according to claim **1**, wherein

in said bucket connecting boss, flange portions located on both the left and right sides of a cylindrical boss portion and extending toward said left and right side plates are provided;

a first V-shaped groove extending in an upper-and-lower direction is provided on each of front ends of said left and right side plates, respectively by cutting away without a root face;

a second V-shaped groove extending in the upper-and-lower direction is provided on rear ends of said left and right flange portions of said bucket connecting boss, respectively by cutting away without a root face; and

each of said first and second V-shaped grooves, without a root face or a gap, respectively, is formed by abutting said first V-shaped grooves of said left and right side plates and said second V-shaped grooves of said left and right flange portions, and each of welding beads is formed by applying welding between said left and right side plates and said left and right flange portions at the position of said first and second V-shaped grooves.

6. The arm for a construction machine according to claim **1**, wherein

a groove extending in a left-and-right direction is provided on each of the front side of said rear, thick upper plate and a rear end of said front, thin upper plate, respectively by cutting away without a root face;

a V-shaped groove without a root face or a gap is formed by abutting said groove of said front side of said rear, thick upper plate and said groove of said rear side of said front, thin upper plate; and

a welding bead is formed by applying welding between said rear, thick upper plate and said front, thin upper plate at the position of said V-shaped groove.

7. The arm for a construction machine according to claim **1**, wherein

a groove extending in a left-and-right direction is provided on the front side of said rear, thick lower plate and a rear end of said front, thin lower plate, respectively by cutting away without a root face;

a V-shaped groove without a root face or a gap is formed by abutting said groove of said front side of said rear, thick lower plate and said groove of said rear side of said front, thin lower plate; and

a welding bead is formed by applying welding between said rear, thick lower plate and said front, thin lower plate at the position of said V-shaped groove.

8. The arm for a construction machine according to claim **4**, wherein

a groove angle of said V-shaped groove is configured to be set within a range of 43 degrees or more and 90 degrees or less.

9. The arm for a construction machine according to claim **1**, wherein

an internal partition wall for reinforcement is provided between said boom connecting boss and a position on an inner surface side of said upper plate and on a front side of a position of a connecting pin provided on each of said pair of left and right bucket cylinder brackets; and

a rear end of said auxiliary welding member is configured to be extended to a rear side of an upper end portion of said internal partition wall.

10. The arm for a construction machine according to claim **1**, wherein

a gap generated between each of said pair of first and second bucket cylinder brackets and said auxiliary welding member on said outer surface of said rear part side of said upper plate is configured to be embedded by a welding bead of each of said pair of first and second bucket cylinder brackets and a welding bead of said auxiliary welding member.

11. The arm for a construction machine according to claim **1**, wherein

said auxiliary welding member is formed having an M-shape in a plan view; and

wherein a notched portion, which is notched having a rearward recessed shape, is provided on a front part side of said M-shaped auxiliary welding member.

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